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Temperature Modeling of Lost Creek Lake Using CE-QUAL-W2

A Report on the Development, Calibration, Verification, and Application of the Model

Tammy L. Threadgill, Daniel F. Turner, Laurie A. Nicholas, Barry W. Bunch, Dorothy H. Tillman, and David L. Smith

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Under Project 329825, “Temperature Modeling of Lost Creek Lake Using CE-QUAL-W2”

Abstract

The Engineer Research and Development Center (ERDC) Environmental Laboratory (EL) assisted the U.S. Army Corps of Engineers (USACE), Portland District (CENWP) in updating a CE-QUAL-W2 (W2) model of Lost Creek Lake based on a previous version of W2. The model was calibrated using data from calendar year (CY) 2001 validated with data from calendar years 2003 and 2010. One set of W2 parameters were successfully applied to all calendar year types (2001 is a dry year; 2003 is a normal year; and 2010 is a wet year). This model and the corresponding study results provided CENWP with more refined estimates of water temperatures so that more defendable water temperature targets can be discussed with the state of Oregon. This is extremely important because the Rogue and Applegate temperature Total Maximum Daily Loads and Rogue Spring Chinook Conservation Plan require USACE to review the Rogue Basin Project operations to determine whether improvements to downstream temperature can be achieved for the benefit of endangered fish. In addition to modeling the basic calibration for three years, a modified version of W2 was used to create a predictive model to determine the best blending of the intake ports to meet the temperature targets.

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Preface

This study was conducted for the U.S. Army Corps of Engineers (CENWP), Portland, Oregon, under Project Number 329825, "Temperature Modeling of Lost Creek Lake Using CE-QUAL-W2."

The work was performed by the Water Quality and Contaminant Modeling Branch (WQCMB), Environmental Processes and Engineering Division (EP), U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL). At the time of publication, Dr. Dorothy Tillman was Chief, WQCMB; Warren P. Lorentz was Chief, EP. Dr. Al Cofrancesco, CEERD-EZT, was the Senior Science and Technology Manager. The Deputy Director of ERDC-EL was Dr. Jack E. Davis and the Director was Dr. Beth Fleming.

COL Bryan S. Green was Commander of ERDC; Dr. David W. Pittman was the ERDC Executive Director.

Unit Conversion Factors

Multiply	By	To Obtain
acre-feet	1,233.5	cubic meters
cubic feet	0.02831685	cubic meters
degrees Fahrenheit	(F-32)/1.8	degrees Celsius
feet	0.3048	meters
gallons (U.S. liquid)	3.785412 E-03	cubic meters
square miles	2.589998 E+06	square meters
Langley per day	0.48	watts per square meter

Acronyms and Units

14WS	14^{th} Weather Squadron
AM	Applegate Lake Model
BOD	Biochemical Oxygen Demand
CENWP	U.S. Army Corps of Engineers, Portland District
CY	Calendar year (January 1 through December 31)
DO	Dissolved oxygen
ELWS	Water surface elevation
ERDC	Engineer Research and Development Center
ISS	Inorganic suspended solids
LCL	Lost Creek Lake
LCLM	Lost Creek Lake Model
NH_4	Ammonium
NO_3	Nitrate
OM	Organic matter
RO	Regulating Outlet
STR_1	Represents the fixed invert intake with centerline elevation of 1852.5 ft
STR_2	Represents the fixed invert intake with centerline elevation of 1797.5 ft
STR_3	Represents the fixed invert intake with centerline elevation of 1737.5 ft
STR4	Represents the fixed invert intake with centerline elevation of 1647.5 ft
STR_5	Represents the turbidity conduit intake with centerline elevation of 1602.5 ft

TDS	Total dissolved solids
TMDL	Total Maximum Daily Loads
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
W2	CE-QUAL-W2 model

1 Introduction

1.1 Objectives

The goal of this project is to develop and calibrate current W2 models for Lost Creek Lake and Applegate Lake so these models can be used to fully evaluate the effects of operational changes on release temperatures at William L. Jess Dam on the Rogue River.

1.2 Background

The Rogue and Applegate temperature Total Maximum Daily Loads (TMDL) and Rogue Spring Chinook Conservation Plan require the USACE to review Rogue Basin Project temperature operations to determine whether improvements to downstream temperature can be achieved for the benefit of fish (ODEQ 2008)(ODFW 2007)(USACE and ODEQ 2009). Oregon Department of Fish and Wildlife (ODFW) will probably also request that the USACE review project temperature operations in connection with the Rogue Fall Chinook Conservation Plan, which was adopted in January 2013 (ODFW 2013).

In the TMDL, the state of Oregon stated that the Corps could evaluate the prescribed temperature targets. This modeling effort refines the estimates of water temperatures at the site of USACE dams in the Rogue Basin and provides more defendable water temperature targets for discussion with the state of Oregon.

Lost Creek Lake is located twenty eight miles northeast of Medford, Oregon on the Rogue River in Jackson, County, Oregon approximately 157.2 miles upstream of its mouth. The William L. Jess Dam was constructed with earth and rock fill and is about 3,600 ft long and about 345 ft high. The primary authorized purposes of the dam are flood damage reduction, fisheries enhancement, irrigation, and municipal and industrial water supply; hydropower, water quality, and recreation are secondary authorized purposes. At maximum pool, Lost Creek Lake is 10 miles long, 3,430 acres, and stores approximately 465,000 acre-ft of water (USACE 1991). Figure 1 is a Google Earth screenshot of the project study area.

Figure 1. Google Earth image of the Lost Creek Reservoir project study area.

1.3 Approach

In order to determine whether the Corps can meet TMDL requirements through operational changes, it was necessary to develop water temperature models of each reservoir. To date, the Corps has in place CE-QUAL-W2 (W2) temperature models for both Lost Creek and Applegate projects. Both projects also have selective withdrawal structures, which allow the projects to release water from fixed elevations in the reservoirs. Both models were run using previous versions of W2 and were calibrated to earlier datasets (90s and prior).

2 Model Selection and Development

W2 is the code selected to develop the Lost Creek Lake Model (LCLM). W2 is a 2D longitudinal-vertical hydrodynamics and water quality model. It is capable of modeling basic eutrophication processes and is best suited for long, narrow waterbodies that do not exhibit substantial lateral variation. W2 has been applied to hundreds of studies on various types of waterbodies (rivers, reservoirs, lakes, and estuaries) all over the world. For a list of the model applications, see the W2 website: http://www.ce.pdx.edu/w2/.

2.1 CE-QUAL-W2 description

The numerical modeling code known as W2, version 3.7 (Cole and Wells 2011), was configured for application to Lost Creek Lake. W2 uses a finite difference solution of the laterally averaged equations of fluid motion (Cole and Wells 2013). It allows for application to very complex water systems because it accommodates multiple branches and multiple waterbody types. W2 allows the user to set up variable grid spacing (longitudinally and vertically), time variable boundary conditions, numerous inflows and outflows, and time variable concentrations for each water quality constituent of interest. W2 (V3.7) contains a user-defined port selection algorithm, which allows the user to specify a varying number of elevations for dam structures. Although this feature is not utilized in the calibration, future scenarios may benefit. In addition to water temperature, W2 is capable of modeling water surface elevation, flow, and twenty-eight water quality constituents such as total dissolved solids (TDS), inorganic suspended solids (ISS), ammonium (NH4), biochemical oxygen demand (BOD), nitrate (NO3), phytoplankton, dissolved oxygen (DO), and organic matter (OM). This study focuses only on temperature; consequently, the other constituents will not be discussed.

2.2 Project approach

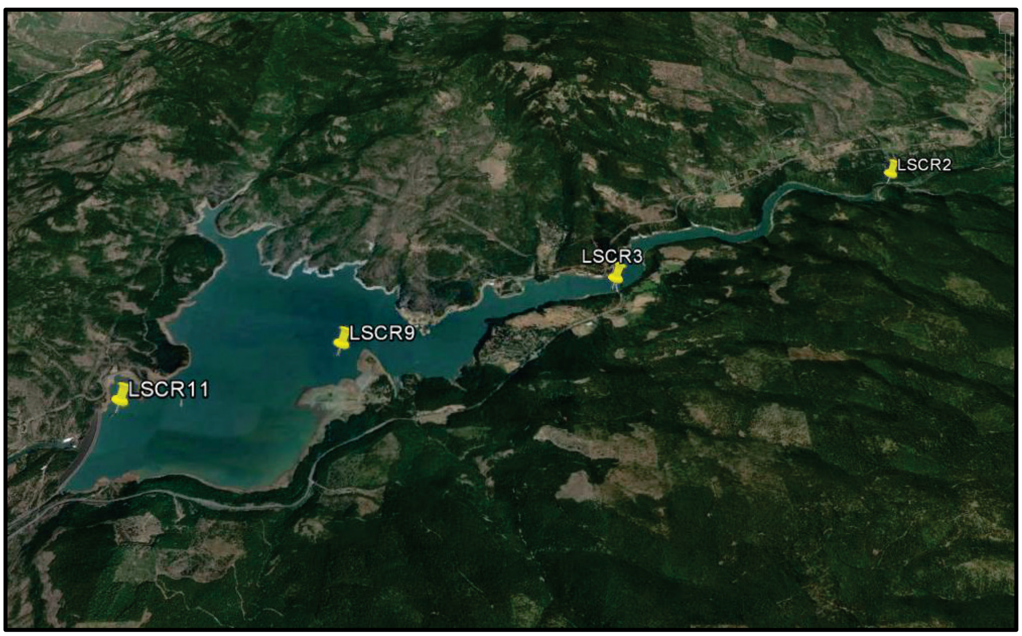
W2 is well-suited for application to Lost Creek Lake for the following reasons:

1. W2 is appropriate for modeling narrow waterbodies with spatially varying depths. Lost Creek Lake is estimated to be 1.5 miles wide at its widest part, but it varies greatly in depths along the length of the reservoir.

2. W2 is capable of modeling hydrodynamics of a reservoir quite well.
3. W2 has been applied to hundreds of systems and is well known, understood, and widely accepted.
4. W2 is capable of providing a wide variety of model output for comparison to observed data.
5. W2 can simulate various responses due to changes in loads and rates.

Three in-lake monitoring stations (LSCR3, LSCR9, and LSCR11) were used for evaluating model performance during calibration. Although temperature data was available from LSCR2, the model grid did not encompass that station (discussed later). Therefore, the LSCR2 data was not used in the calibration process. Temperature data at the dam and downstream from the dam were also used for calibration. The locations of the sites are shown in Figure 2.

Figure 2. In-lake profile monitoring stations.
Site locations provided by Kinsey Friesen (CENWP).



2.3 Calibration strategy

Several factors were used to determine which calendar years (CY) were used to calibrate and validate the model. The largest limiting factor was the availability of observed data. Since more data was available for 2001, CY01 was used to develop a calibrated model. Once an acceptable set of calibration parameters were found, the same set of model parameters were used for CY03 and CY10. Each of the years represents various water year types: 2001 was a dry year, 2003 was an average year, and 2010 was a wet year.

3 Data Analysis and Model Preparation

This section reviews data availability and their use in defining the calibration input files. W2 has several data requirements to meet before simulations can begin:

1. Bathymetry of the waterbody(ies)
2. Flow and temperature characteristics for boundaries, major tributaries, and point sources
3. Dam operations and structure locations
4. Stage data
5. Meteorological conditions: air temperature, dew point temperature, wind speed, wind direction, cloud cover, and short wave solar radiation (if available)

3.1 Model geometry

3.1.1 Bathymetry data

The bathymetry file for the LCLM was originally developed by Mike Schneider (USACE) for the original W2 model of Lost Creek Lake. Due to lack of documentation, it is unknown where he obtained the bathymetry data (sediment range analysis, cross sections, etc.). The current model utilized the original bathymetry file and then refined the grid. Upon completion of this model update, CENWP completed a new survey of the reservoir. Due to time constraints and analysis of the data by CENWP, ERDC decided to not update the model with the new bathymetry.

3.1.2 Model grid development

Lost Creek Lake was split into two branches, with Branch 1 extending from the Rogue River just downstream from Prospect, OR, approximately 7 miles to the dam, and Branch 2 is a side channel that enters the mainstem of the reservoir about 1.5 miles upstream from the dam. The reservoir was modeled with 58 longitudinal segments, varying in length from 200.0 to 350.0 m, and 104 vertical layers of uniform 1 m (3.28 ft) height.

Table 1 provides a description of the branches in the reservoir; the segment numbers do not include the inactive (or "null") segments that start and end each branch (required in W2). Figure 3 shows an image of the longitudinal segments used in the model along with the branch configuration, and Figure 4 is a Google Earth image with the model grid overlay.

Table 1. Geometry characteristics.

Description	Branch	Segment Start	Segment End	# Segments	Slope
Mainstem – Prospect to Dam	1	2	47	46	0.000
Branch 2 – Ungauged leg of the lake	2	50	57	8	0.000

Figure 3. Longitudinal segments with branch configuration for the LCLM.

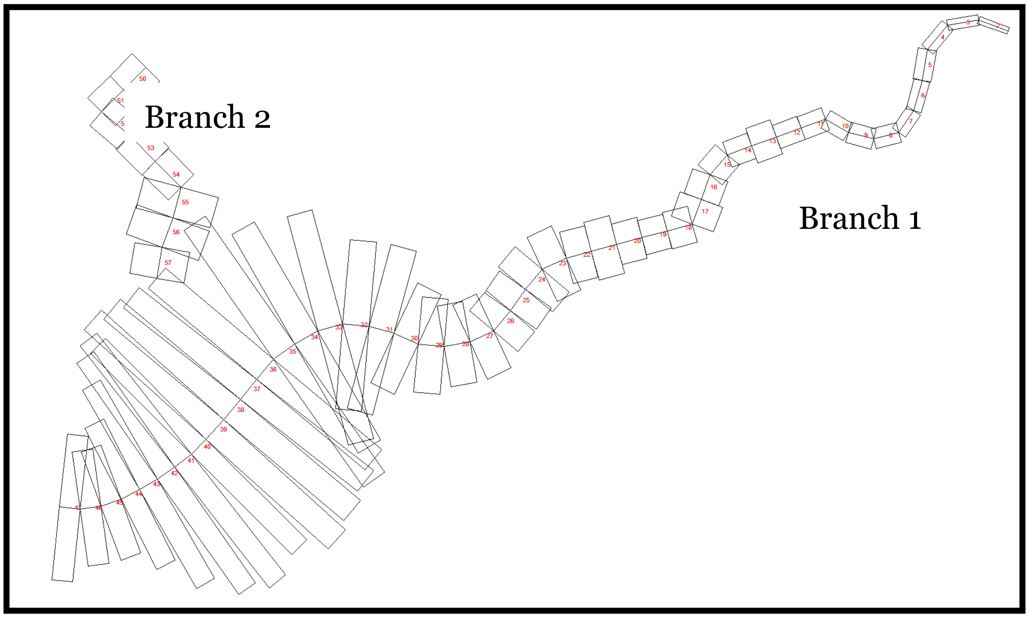
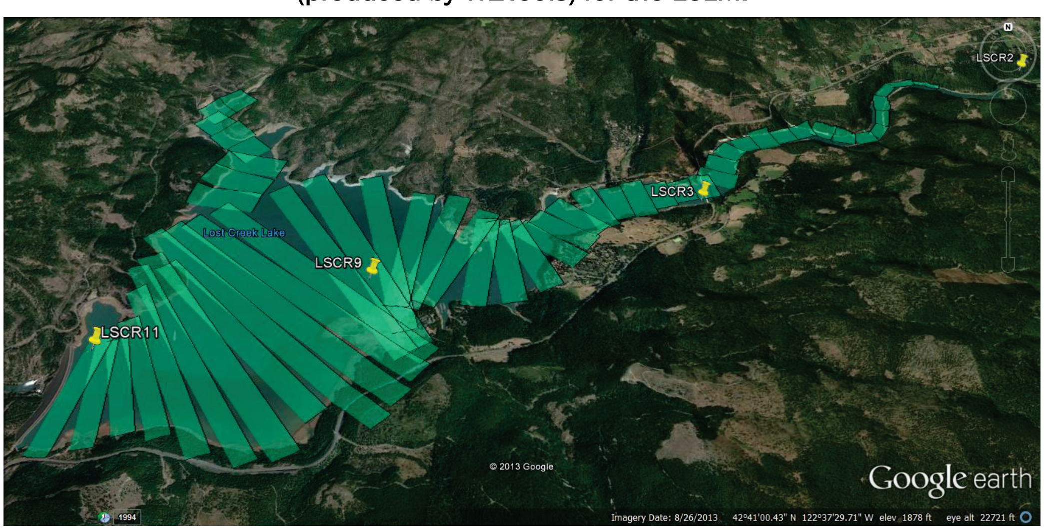


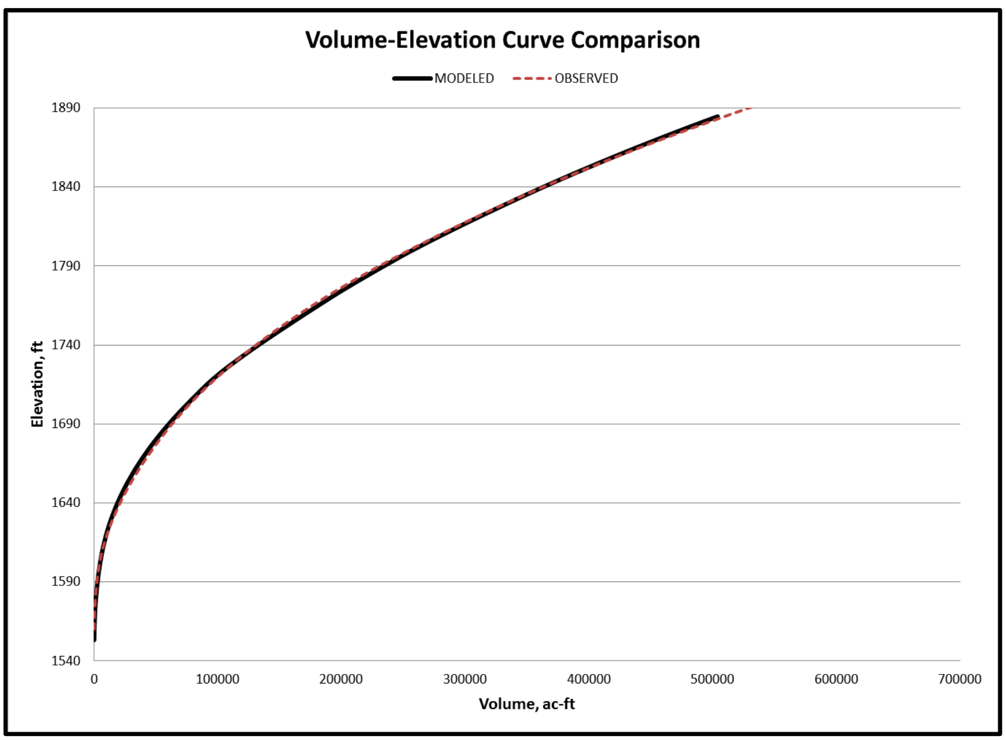
Figure 4. Google Earth image with model grid overlay (produced by W2Tools) for the LCLM.



The bathymetry of the LCLM that has been developed has been verified to replicate the observed storage-elevation curve (obtained from CENWP). Figure 5 shows the storage-elevation curve represented by the model compared to the observed storage-elevation curve (or volume-elevation curve). This provides ERDC with confidence that the bathymetry is good and sufficient for the LCLM. A complete copy of the bathymetry file is in Appendix A. All model input files were delivered to CENWP.

As stated previously, another in-lake profile station was available for CY01; however, due to the fact that the bathymetry did not extend the full length of the true reservoir, this station (LSCR2) was not considered for model evaluation purposes. In order to best represent the full reach of the reservoir and incorporate the bottom elevation changes, the model would need to be set up with two waterbodies: one river and one reservoir. Setting the current model up this way is outside the scope of this project due to the complexity of developing a riverine-reservoir model.

Figure 5. Volume-elevation curve comparison for the LCLM.



3.1.3 Dam features and withdrawal locations

Table 2 presents an abbreviated list of segment numbers in the LCLM bathymetry with a brief description of what site is located at the segment.

For example, the in-lake monitoring site, LSCR11, is represented by segment 47, which is the dam, in the LCLM bathymetry.

Table 2. Model segments of important locations.

Segment	Length (m)	Distance Upstream from Dam(m)	Distance Upstream from Dam (miles)	Identification/Location
1	0.000	0.000	0.000	Boundary (Null Segment)
2	300.000	11150.000	6.928	Beginning of Branch 1
18	250.000	6900.000	4.287	In-lake Station: LSCR3
34	250.000	2900.000	1.802	In-lake Station: LSCR9
36	250.000	2400.000	1.491	Branch 2 Enters Here
47	200.000	0.000	0.000	Dam/In-lake Station: LSCR11
48	0.000	0.000	0.000	Boundary (Null Segment
49	0.000	0.000	0.000	Boundary (Null Segment
50	300.000	2550.000	1.584	Beginning of Branch 2
57	300.000	300.000	0.186	End of Branch 2
58	0.000	0.000	0.000	Boundary (Null Segment

3.2 Flow and elevations

3.2.1 Model inflow boundaries

3.2.1.1 Upstream and downstream boundaries

Mean daily flow for the Rogue River below Prospect, OR (14330000) was available from the United States Geological Survey (USGS) for all years for both calibration and validation of the model. Flow from this site was used as the upstream boundary condition. However, the measured flow did not include flow from the South Fork Rogue River, the confluence of which is between the head of the reservoir and the Rogue River gage. All branches in W2 require input files for flow and temperature. However, since the second branch in this case does not have a major inflow, a dummy file of zero flows was used as input for the model. This branch was modeled to capture the geometry of the reservoir and to maintain the volume-elevation relationship. In essence, this will have no impact on the model. The model will fill solely using the upstream inflow. At the downstream boundary, located at the dam, total outflows were available for all calendar years from the Northwestern Division Corps Water Management System (CWMS) database. The elevation data available at the dam were used solely for model-to-data comparison.

The flow from the monitored station above (Rogue River below Prospect, OR) does not account for all flows into the reservoir. The South Fork Rogue River also accounts for a large amount of flow; however, recent data is limited for this river. There are two stations available on the South Fork Rogue River, but the active station is approximately 10 miles upstream from the confluence with the Rogue River. Due to the inaccuracy associated with flow estimation, a decision was made to account for any water balance issues by using the water balance utility (available with the W2 download).

Table 3 displays the data sources for flow and elevation for various locations: the upstream boundary (PRSO), the downstream boundary (William Jess Dam), and three in-lake locations in the lake. Figure 6-Figure 8 are plots of all flow data used as input for the model at the upstream and downstream boundary for all three calendar years.

Table 3. Data sources for flow and elevation at the model boundaries.

River/Location Name	Mile	Location and ID	Source	Variable	Calendar Year
Rogue River below Prospect	169.4	PRSO; USGS #14330000	USGS	Flow, Mean Daily	2001, 2003, 2010
William L. Jess Dam	157.2	LOS; USGS #14335040	CENWP	Elevation, Mean Daily	2001, 2003, 2010
William L. Jess Dam	157.2	LOS; USGS #14335040	CENWP	Flow, Mean Daily	2001, 2003, 2010

Figure 6. Flow input data for upstream and downstream boundaries for CY01.

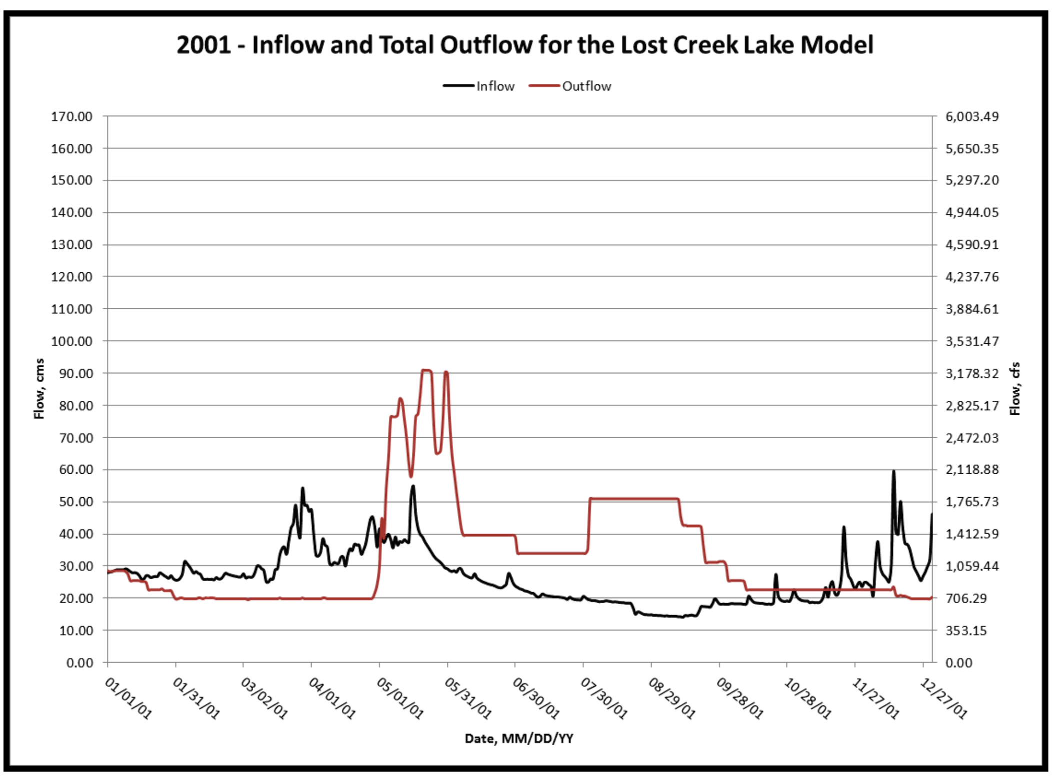


Figure 7. Flow input data for upstream and downstream boundaries for CY03.

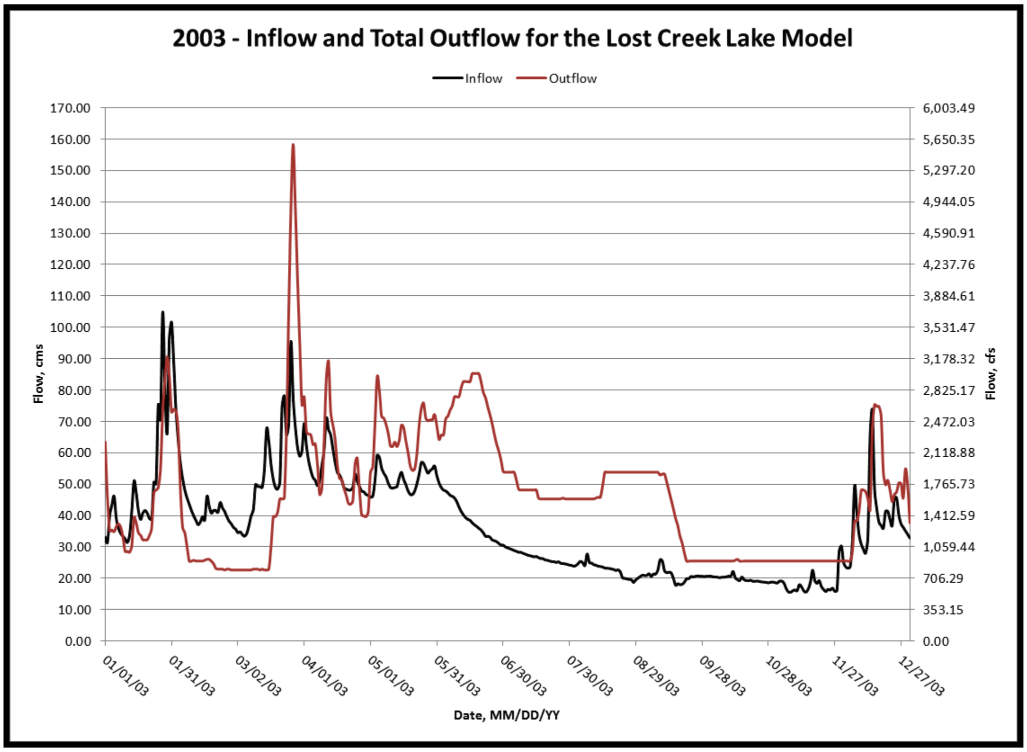
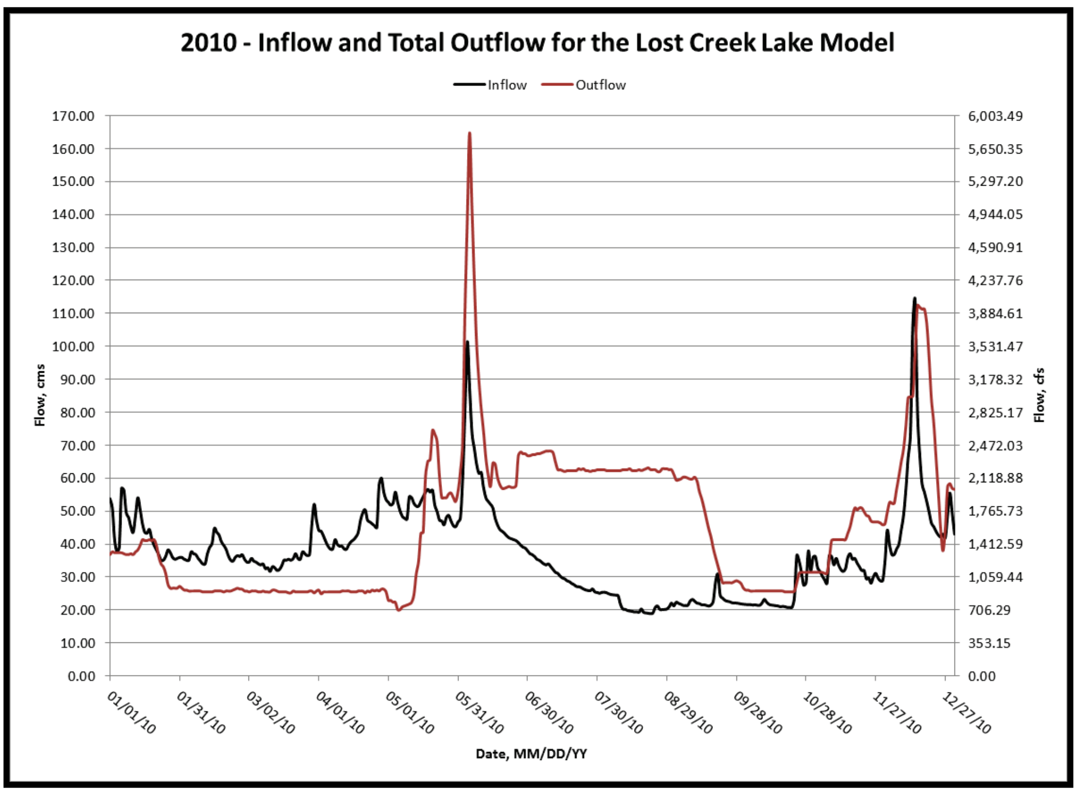


Figure 8. Flow input data for upstream and downstream boundaries for CY10.



3.2.1.2 Tributaries

No gauged streams discharge into Lost Creek Lake. For this reason, no tributaries were defined in the model. However, when ERDC obtained the original model files from CENWP, only one inflow was specified: USGS flow at Prospect, OR (USGS 14330000). There appeared to be a correction applied to that version of the model as well as in subsequent simulations. The assumption is that the correction is accounting for the additional inflow from the South Fork Rogue River (see Figure 9). The model from CENWP was initially calibrated and run for 1990, 1991, and 1999. In more recent years, however, the flow at the closest gauged station (USGS 14334700) to the reservoir is inactive (monitoring ceased in 1992); the next closest active station on the South Fork Rogue River is approximately 10 miles upstream. The flow here (USGS 14332000) underestimates the actual total flows into the lake (see Figure 10); for this reason alone, ERDC decided that instead of making two corrections (adding flows at Prospect and having a distributed tributary) to account for the flow, the model would be better simply by having one correction factor to the flows: the distributed tributary.

Due to the variation observed water surface elevations in early 2003, the model for 2003 had to be run two times in order for the model to best fit the observed water surface elevations. Again, the distributed tributary is used typically when there are ungauged flows entering the system. In this case, the flows are mostly from the South Fork McKenzie River. Figure 11 is the total flow that was added to the system to account for the water balance problems.

Figure 9. USGS Map of all surface-water sites near upstream boundary.

Figure 10. Historical flows (through 1992) for the upstream stations.

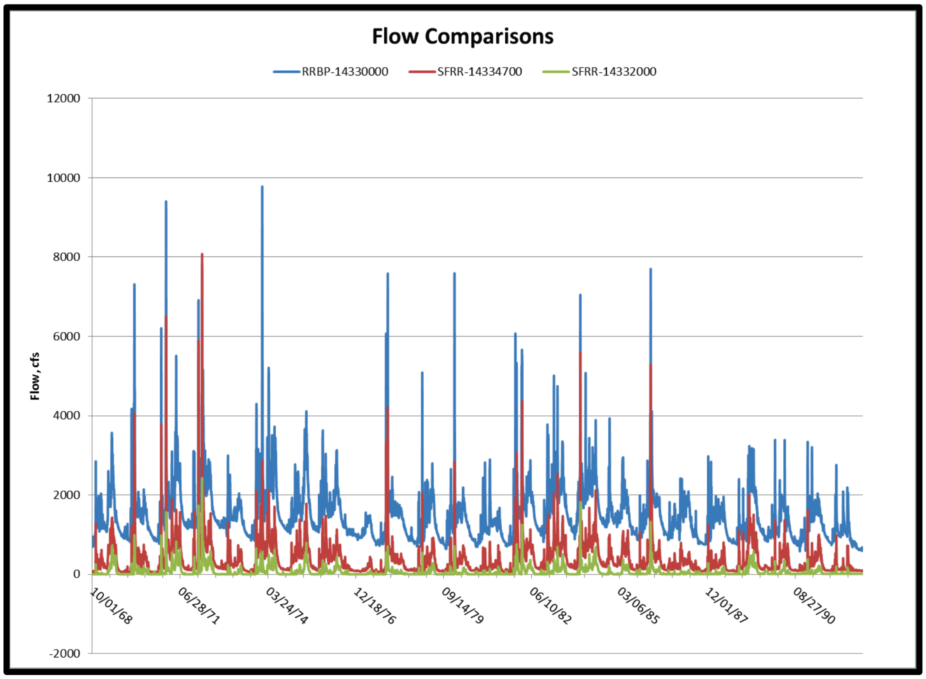
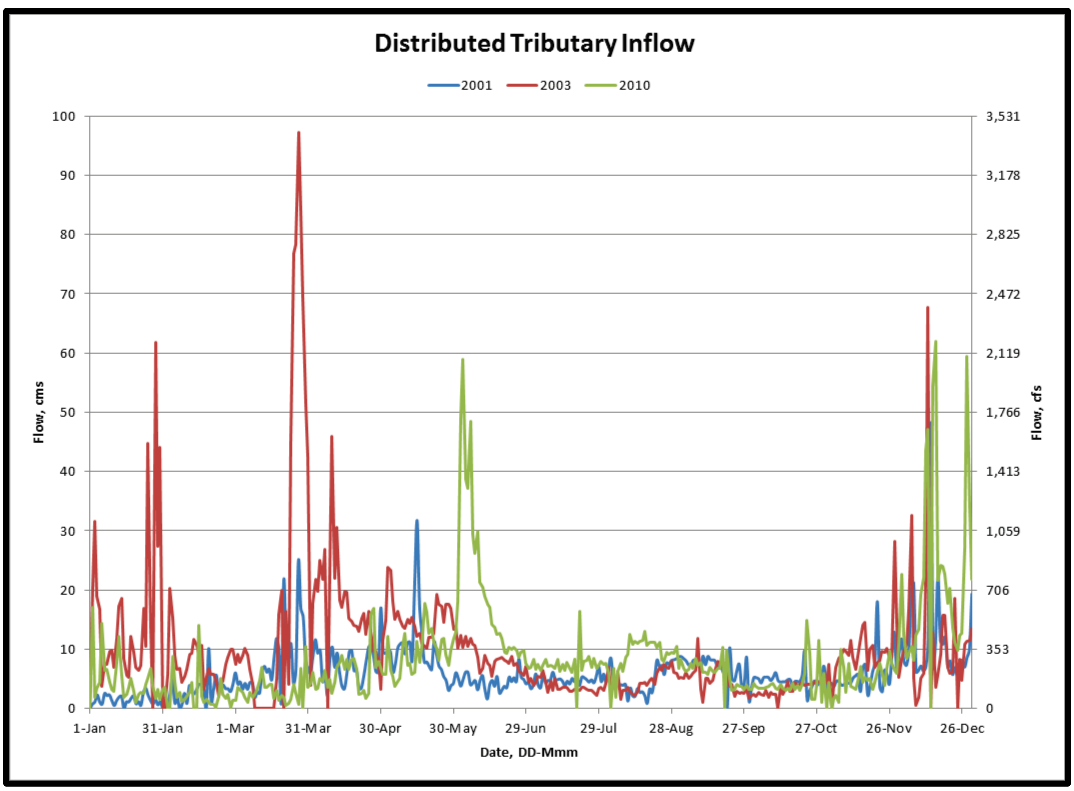


Figure 11. Distributed tributary inflow input data.



3.2.2 Model outflow boundaries

The amount of flow withdrawn through each intake port is not measured; however, gate settings are recorded. Gate settings information was obtained from CENWP as an Excel spreadsheet. These values were then used to develop the necessary file for W2 (QWO file).

Figure 12-Figure 14 is a plot of the outflow specified at each intake structure. ERDC applied conditions to the total outflow based on elevations and operations procedures as detailed in the *Master Water Control Manual* (USACE 1991) to apportion the total outflow to each intake port.

Figure 12. Outflow input data at specified structure for CY01.

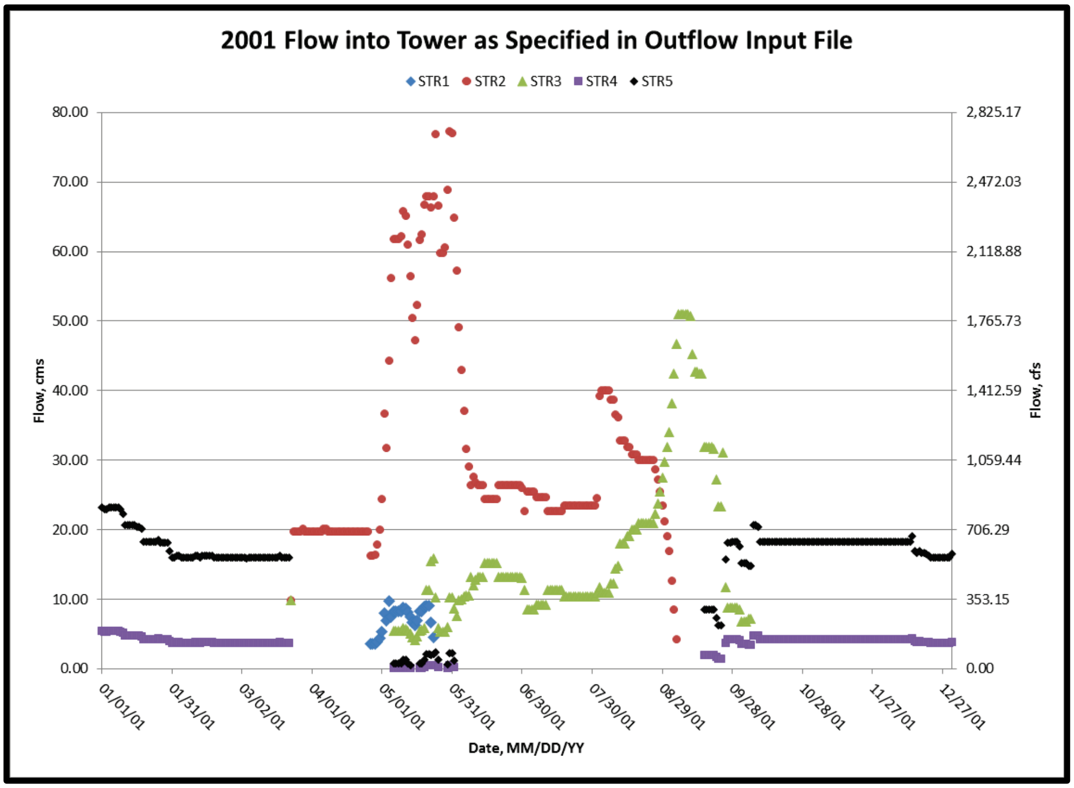


Figure 13. Outflow input data at specified structure for CY03.

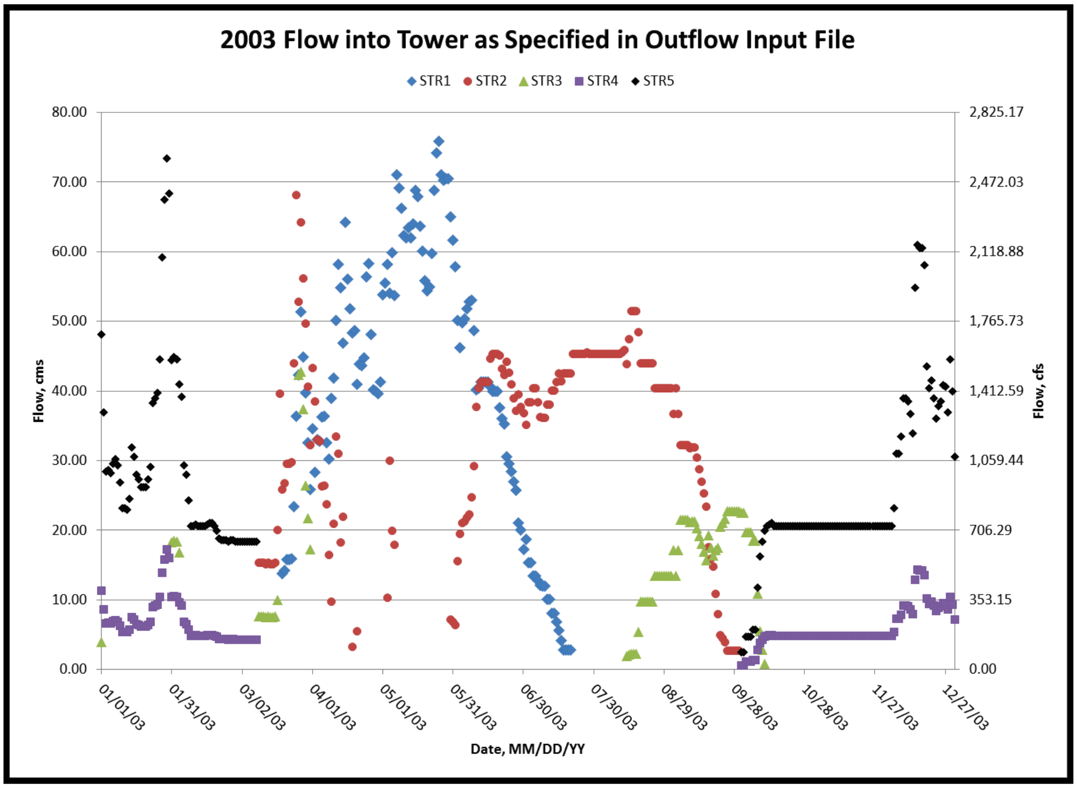
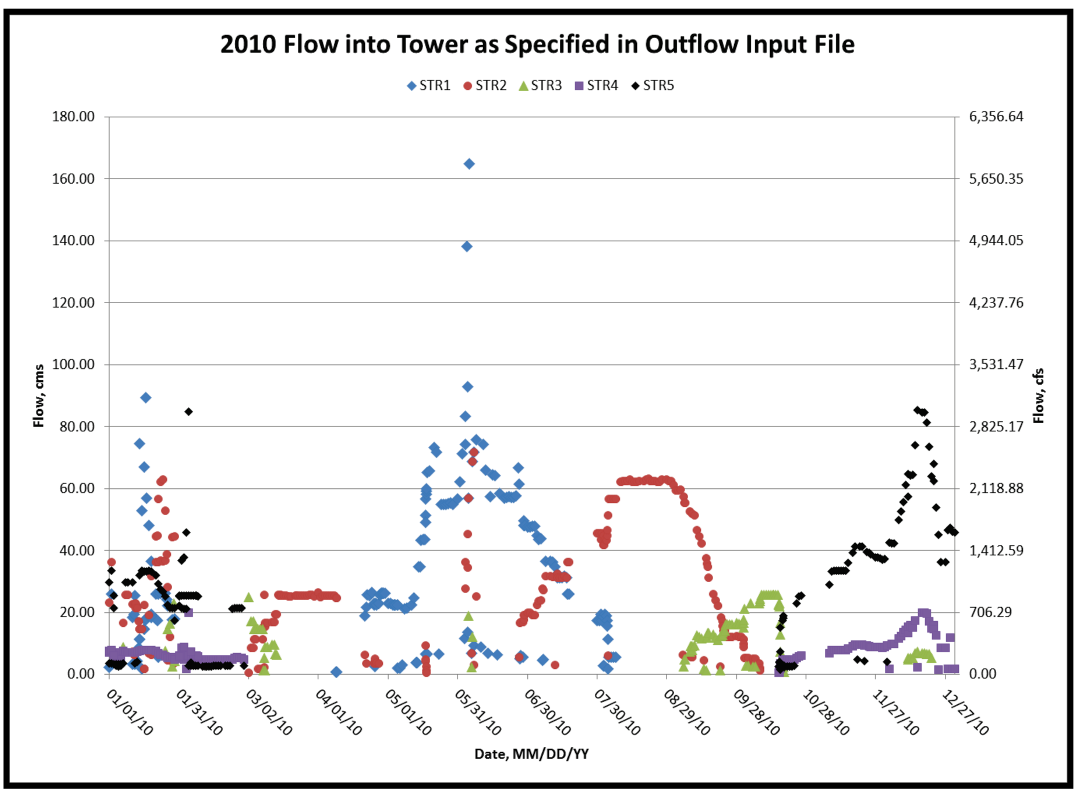


Figure 14. Outflow input data at specified structure for CY10.



3.3 Temperature

3.3.1 Model boundaries

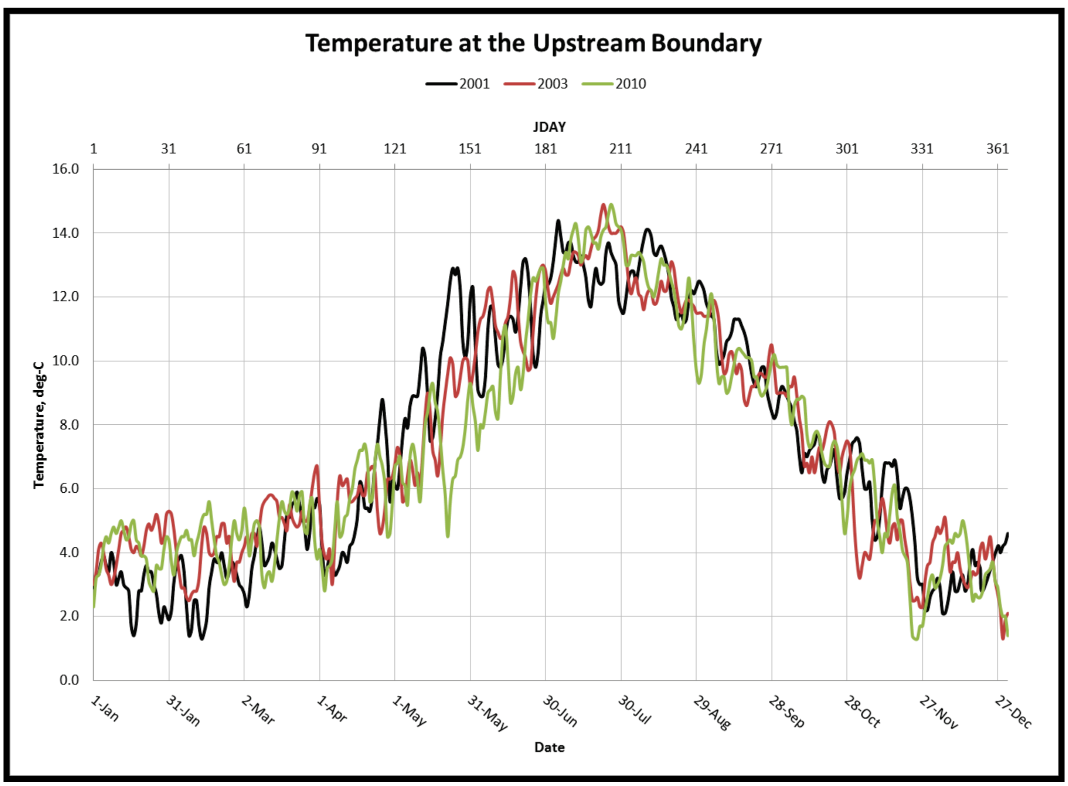
For all calendar years, temperature at the upstream boundary was defined with mean daily temperature from the Rogue River at Prospect (USGS 14330000). Temperature at the upstream boundary was also used as input for the second branch. However, since flows for the second branch are input as zero, the temperature will have no impact on the model.

Temperature data at the dam were used as calibration data for the model. Table 4 presents the locations and sources for temperature data, and Figure 15 provides a time-series plot of temperature at the upstream boundary as defined in the model for all calendar years.

Table 4. Data sources for temperature at the model boundaries.

River/Location Name	Mile	Location and ID	Source	Variable	Calendar Year
Rogue River below Prospect (Upstream Boundary)	169.4	PRSO; USGS #14330000	USGS	Temperature, Mean Daily	2001, 2003, 2010
William L. Jess Dam (Downstream Boundary)	157.2	LOS; USGS #14335040	CENWP	Temperature, Mean Daily	2001, 2003, 2010

Figure 15. Temperature input data for the upstream boundary for 2001, 2003, and 2010.



3.3.2 Tributaries

Since tributaries were not monitored, there are none being modeled. However, because a distributed tributary must be used to improve the water balance, the upstream temperature input file was duplicated and used as input temperature for the distributed tributary. There was no temperature data available at any other gages (South Fork McKenzie) for the time period modeled; for that reason alone, the upstream boundary temperature was used as input for the distributed tributary.

3.4 Meteorological data

Hourly meteorological data were requested from the 14th Weather Squadron (14WS) at Medford, OR (28 miles southwest of Lost Creek Lake). Figure 16-Figure 21 provide a mean daily time-series plots for various meteorological conditions at the upstream boundary as defined in the model for CY01.

Figure 16. Air and dewpoint temperature input data for 2001.

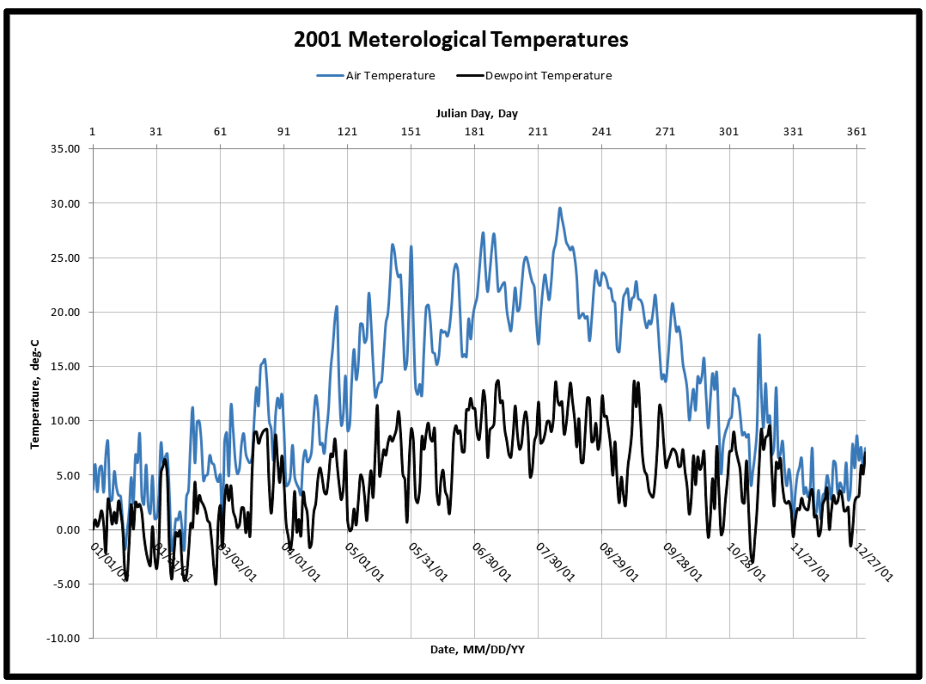


Figure 17. Air and dewpoint temperature input data for 2003.

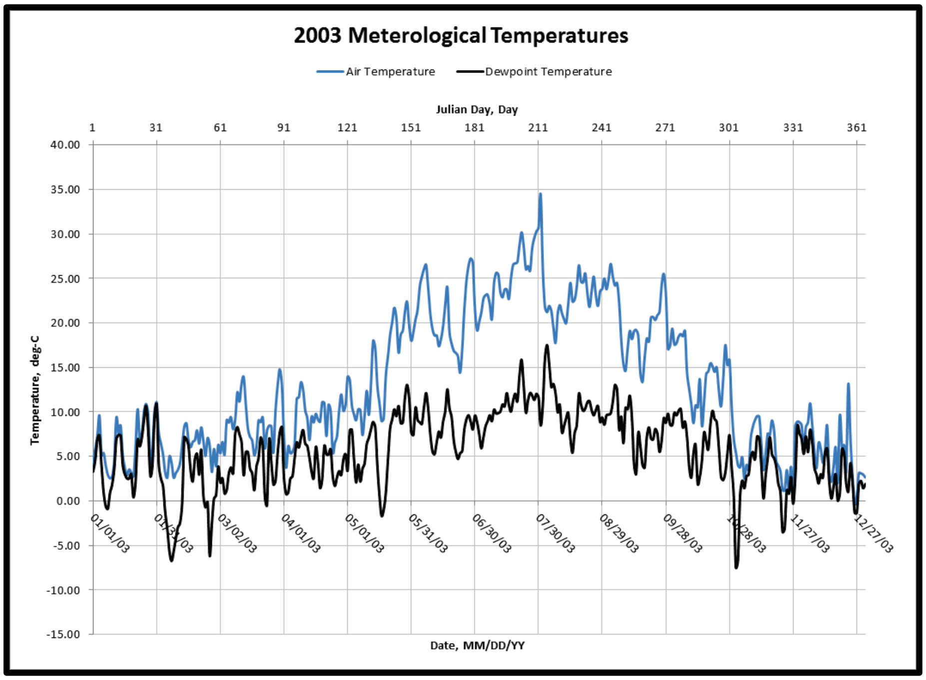


Figure 18. Air and dewpoint temperature input data for 2010.

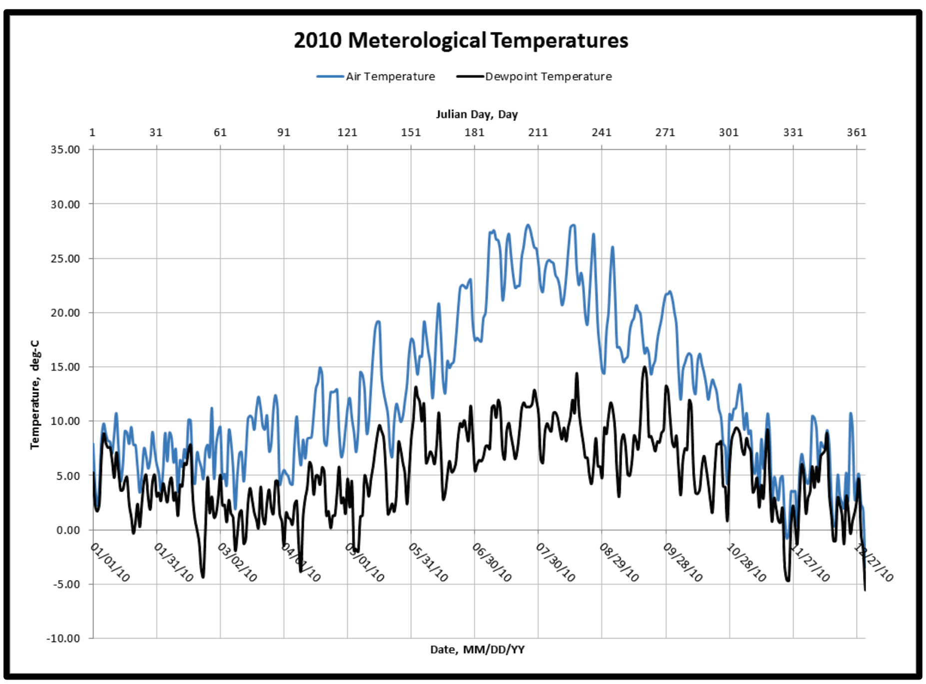


Figure 19. Cloud cover input data for 2001.

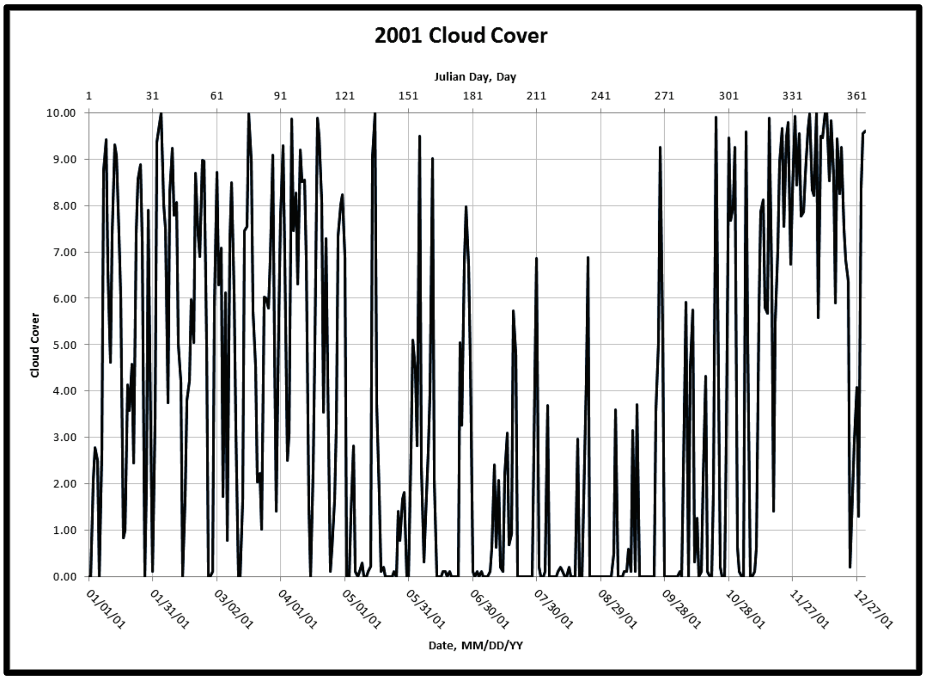


Figure 20. Cloud cover input data for 2003.

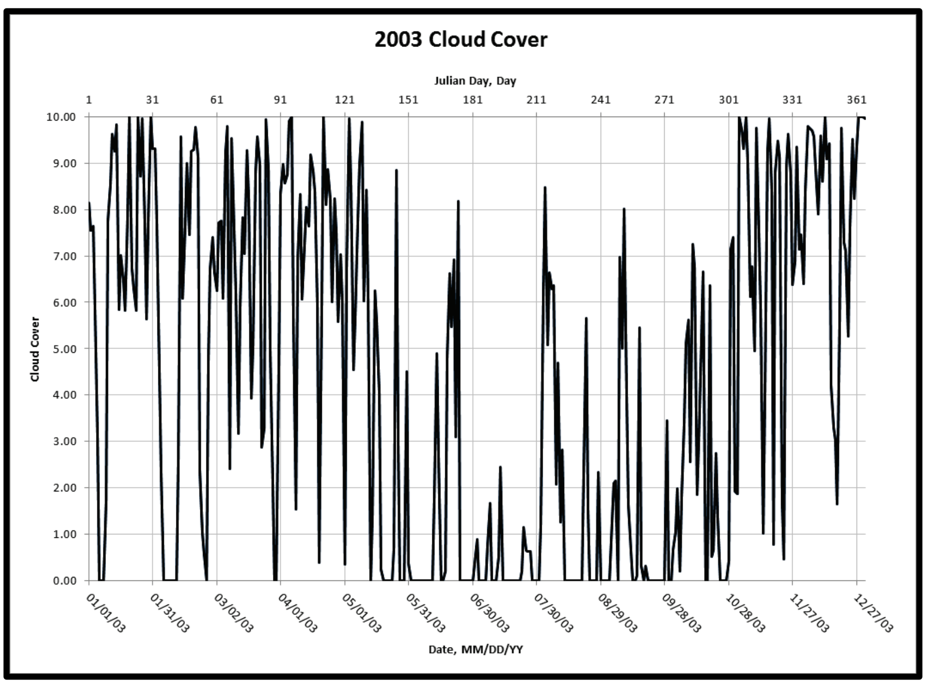
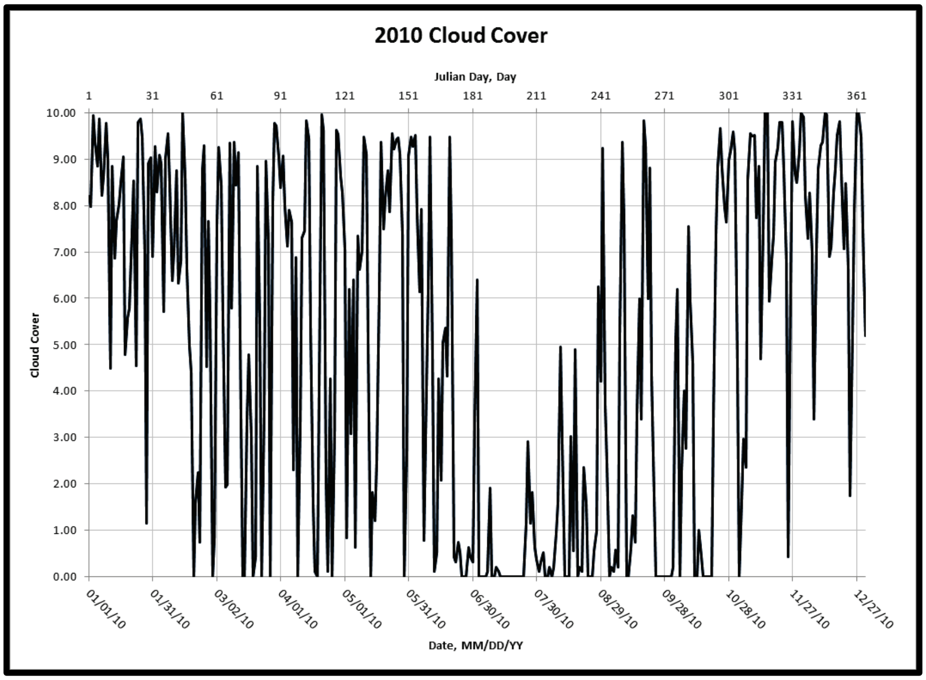


Figure 21. Cloud cover input data for 2010.



3.5 CE-QUAL-W2 control file

The control file for the model calibration (CY01) can be found in Appendix B along with a table detailing any differences for all other model simulations. In order to keep this section concise, only parameters related to temperature are discussed.

3.5.1 Calculations, transport scheme, and heat exchange

Since evaporation is always considered in the surface heat exchange calculations in W2, it is important to turn the evaporation calculation (EVC) on if needed. According to the manual, if calculated inflows are used in setting up a model, then EVC is set to OFF; however, in the case of the LCLM, EVC is set to ON since we are using direct USGS inflows and evaporation is not included in USGS flows.

The transport solution scheme used in the LCLM is the ULTIMATE scheme, which is a higher order solution scheme that reduces numerical diffusion and eliminates the over- and undershoots that the QUICKEST scheme generates near regions of shear concentration gradients (Cole and Wells 2013).

In the W2 control file, the user must specify heat exchange parameters. The first parameter specified is the approach used for computing surface heat exchange (SLHTC). For the LCLM, ERDC chose to use a term-by-term (TERM) heat exchange because it is more theoretically sound according to Cole and Wells (2013) and because it produced better model results than the equilibrium temperature method (ET). Shortwave solar radiation was available, but ERDC chose to the let the model calculate it internally because this produced better results (SROC = OFF). Although ERDC was provided with hourly meteorological data, W2 was still allowed to interpolate the input data to correspond to the model time-step by setting the METIC parameter to ON. The wind speed measurement height was set to 10 m in the LCLM as indicated by the 14WS. All other heat exchange parameters were set to the suggested manual values.

3.5.2 Extinction coefficients

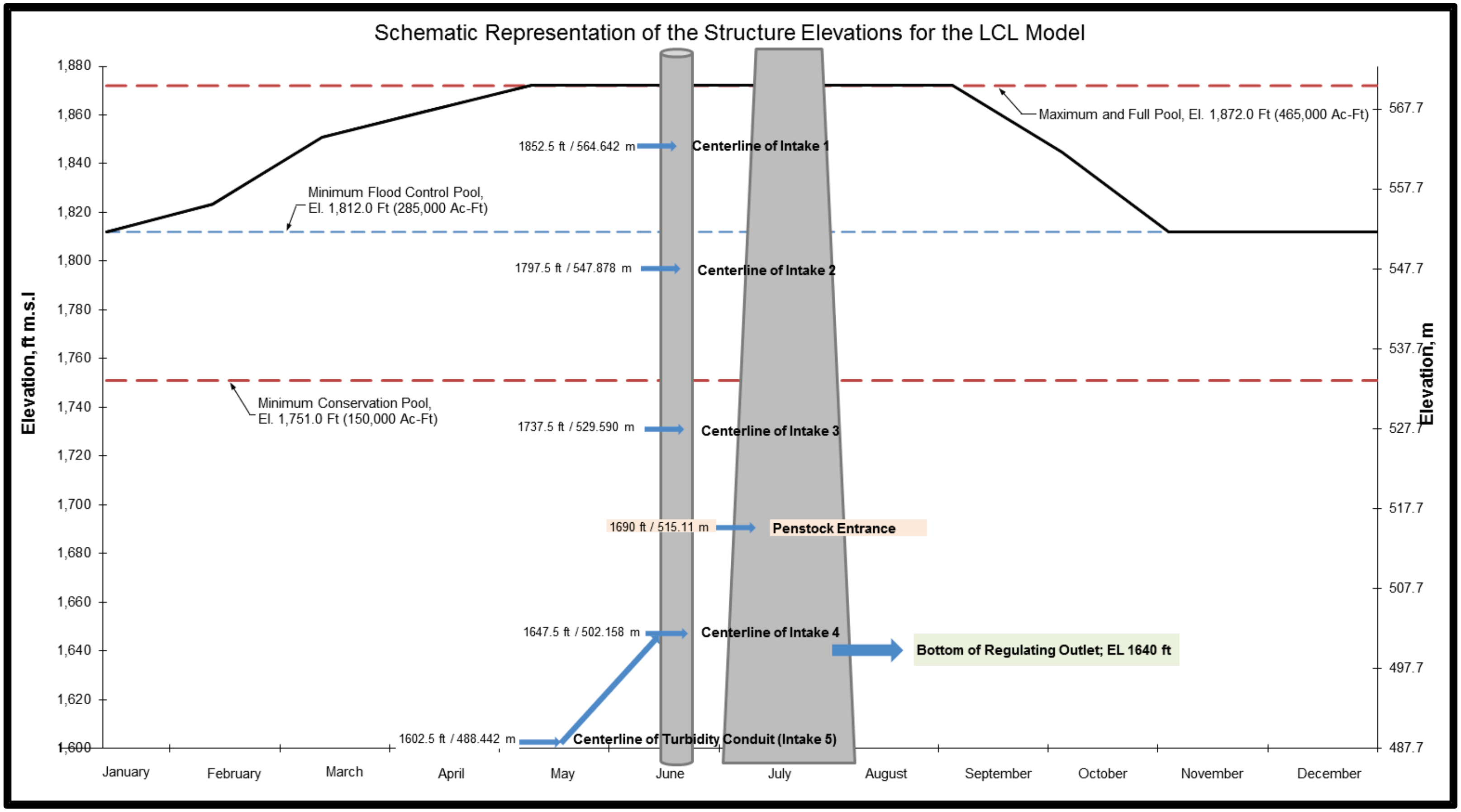
The extinction coefficient card contains two important coefficients for temperature calibration. The extinction coefficient for pure water (EXH20) is set to 0.55 m^{-1}, which is greater than the default value for a temperature-only model (0.45 m^{-1}). However, the value is within the range of values for EXH2O for oligotrophic to eutrophic lakes, 0.2-1.66 m^{-1}; the higher value accounts for the turbidity of the lake. The BETA parameter determines the fraction of incident solar radiation absorbed at the water surface and is also set to the value of 0.55 in the LCLM model. The W2 manual suggests that typical values for BETA are approximately 0.2-0.7 (Cole and Wells 2013).

3.5.3 Selective withdrawal

W2 is capable of modeling a temperature control tower with selective withdrawal features. The latest version also has the added capability of dynamic port selection; however, since this was not used for the current model, it will not be discussed here.

The Lost Creek Lake Water Temperature Control tower (WTC) has five intake structures into a common wet well: four water temperature control ports and one turbidity conduit. The turbidity conduit is used throughout the year to act as a water temperature control port or to flush the lower levels of the reservoir. The conduit is connected to the middle of the lowest fixed port at elevation 1,640 ft and is often responsible for 81% of the flow entering the tower through that lowest port (USACE 1991). Figure 22 is an image of where each intake port is identified in the model control file. Two additional intakes are located on the WTC but neither use the tower wet well: a tower bypass intake and fish hatchery warm water supply intake. These two intakes are not explicitly represented in the model because their flow rates are negligible.

Figure 22. Schematic representation of the water temperature control port elevations. (This includes minimum head requirements).



4 Model Calibration – CY01

Final calibration results are presented in this section. In all of the time series plots shown, a black solid line represents model output, a solid red circle or solid or dashed red line represents measured data. Three statistics are also presented in the charts: mean error (ME), absolute mean error (AME), and root mean square error (RMSE). These statistics are calculated as shown in Equations 1-3. The model was output every day as a daily average; when making time series comparisons to the observed data, a tolerance of 0.5 days was used for the model output so that model output and measured data were compared spatially and temporally with minimal averaging. A tolerance of seven days was used for the model output when making profile plot comparisons. In both of the cases, the statistical comparison is a one-to-one comparison. We use the closest date and the closest depth for comparing values. The tolerances used also allowed enough spacing to avoid observed data averaging.

$$ME = \frac{\sum_{1}^{n}(model - data)}{n} \tag{1}$$

$$AME = \frac{\sum_{1}^{n}abs(model - data)}{n} \tag{2}$$

$$RMSE = \sqrt{\frac{\sum_{1}^{n}(model - data)^2}{n}} \tag{3}$$

Cumulative distribution plots are also presented in this section. For these plots, the solid black line represents model output and the dashed red line represents observed data. These plots are used to indicate how the model is behaving overall when compared to the observed values. For example, at high temperatures, the model over-/underpredicts temperature by XX deg-C, where XX represents the AME value. Scatter plots are also presented to give a statistical representation of how the model is behaving.

A general rule of thumb for water quality calibration is that the absolute mean error should be within 10% of the range of monitored data[1], temperature AME should be within 1 deg-C (~1.8 deg-F), and elevations should be within 0.5 m (1.64 ft). Equation 4 is the equation used to calculate the target values for AME. These target values were calculated for each calendar year and will be presented in tabular form in the following sections. Units for these targets are consistent with the minimum and maximum values for each constituent. For example, for flow, the minimum, maximum, the AME, and 10% target are presented in cubic feet per second.

$$\text{Target} = 0.10*((\text{maximum observed value}) - (\text{minimum observed value})) \quad (4)$$

4.1 Flow

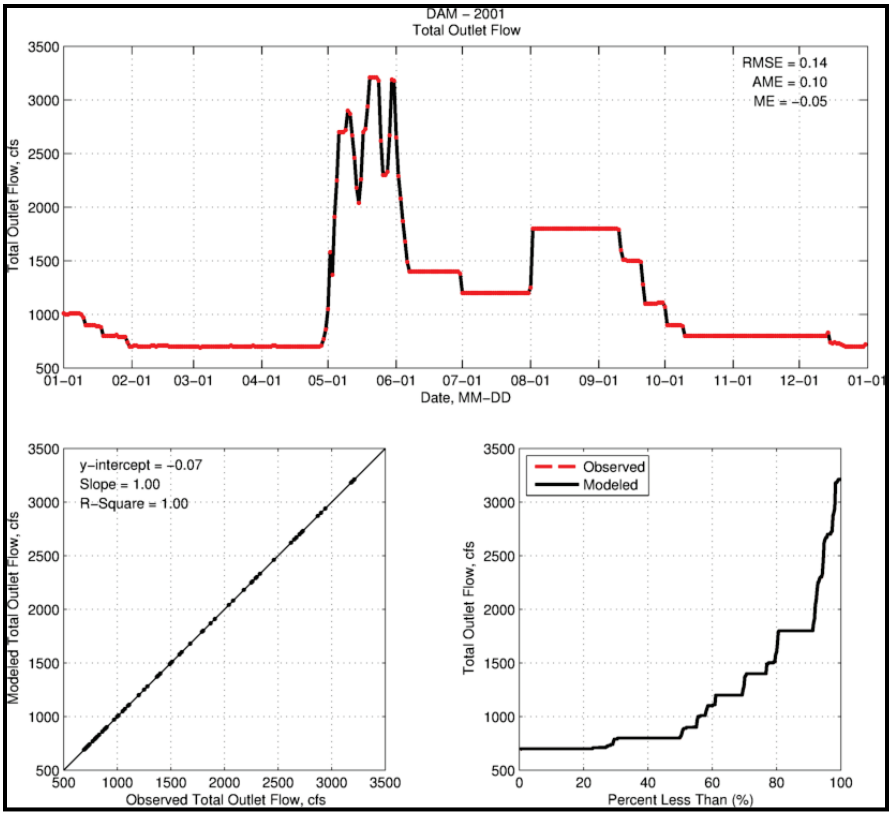
Since the model upstream boundary condition segment often changes based on the reservoir volume, ERDC cannot produce flow plots to verify that the upstream boundary condition for flow is satisfied. Model output along with observed data for CY01 at the dam is shown in Figure 23. Note that this is really just a representation that the data is being read correctly from the input outflow file. The AME for all data pairs for 2001 at the dam is 0.10 cfs, which is well less than 0.5% of the measured range of flows the calendar year. Table 5 presents several basic stats for flow. Based on Figure 23, the slope of the trendline fitted through the data pairs is 1.00 and the R-squared value is 1.00. Overall, the model only underpredicts outflow at the dam by 0.05 cfs.

Table 5. Basic statistics for flow (cfs) for CY01 calibration.

SITE	Observed Minimum	Observed Maximum	AME	ME	Slope	R-Squared
Dam	690.00	3210.00	0.10	-0.05	1.00	1.00

[1] Wells, Scott. 2008. Personal communication with Tammy Threadgill. June 15. CE-QUAL-W2 Workshop, Portland, OR.

Figure 23. Withdrawal flow at the dam for CY01 calibration.



4.2 Temperature

The best hope in correctly predicting the outflow temperature is to correctly predict the in-lake temperature profiles at various locations in the reservoir. If the temperature profiles are not satisfactory, the chance of correctly predicting total outflow temperature is highly unlikely. Profile plots and statistical plots for all in-lake monitoring sites are presented in Figure 24-Figure 29. (Figure 2 shows the location of each of these sites.) A time series plot and statistical plots are presented for the dam in Figure 30. The average AME for each of the in-lake sites are within the acceptable target. Table 6 presents the calculated AME and the temperature target that ERDC attempted to reach for the in-lake sites and for the outflow temperature at the dam. Based on Figure 27-Figure 29, the average slope of the trendlines is 1.12, and the R-squared value is 0.91 for the in-lake sites. Based on the figures below, the model underpredicts the temperature by an average of 0.56 deg-C at the downstream in-lake sites and overpredicts temperature by approximately 0.50 deg-C at the furthest upstream in-lake site (LSCR3). At the dam, the AME is 0.56 deg-C, with a slope of 1.08 and an R-squared value of 0.98 (see Figure 30).

Table 6. Basic statistics for temperature (deg-C) for CY01 calibration.

SITE	Observed Minimum	Observed Maximum	Target AME	AME	ME	Slope	R-Squared
LSCR11 (CY AVG)	5.06	20.61	1.00	0.68	-0.17	1.08	0.96
LSCR9 (CY AVG)	5.03	21.15	1.00	0.90	-0.22	1.13	0.94
LSCR3 (CY AVG)	8.65	16.60	1.00	0.89	0.82	1.04	0.94
Dam (Outflow)	4.50	14.78	1.00	0.52	-0.12	1.13	0.98

Figure 24. Temperature profiles at LSCR11 in CY01 calibration.

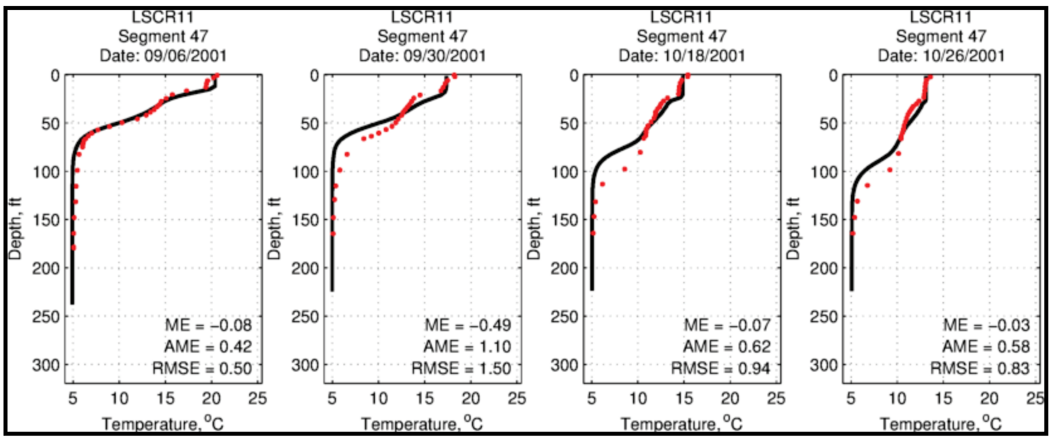


Figure 25. Temperature profiles at LSCR9 in CY01 calibration.

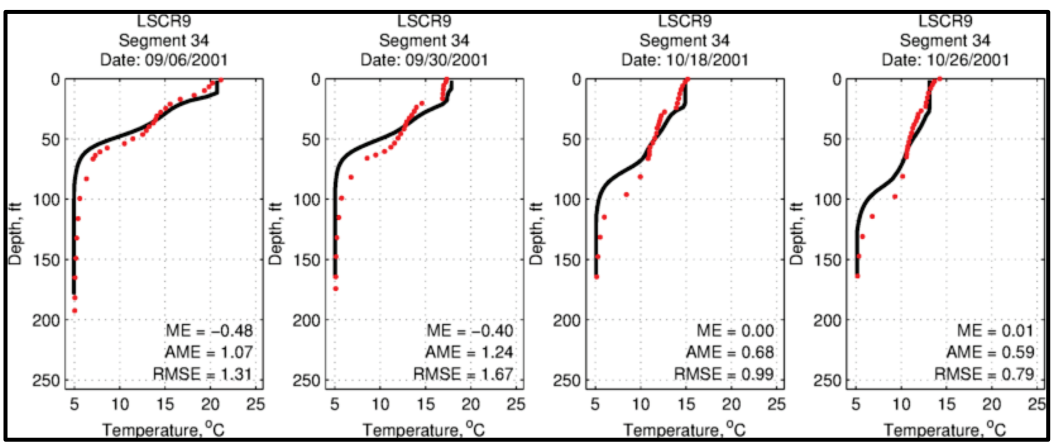


Figure 26. Temperature profiles at LSCR3 in CY01 calibration.

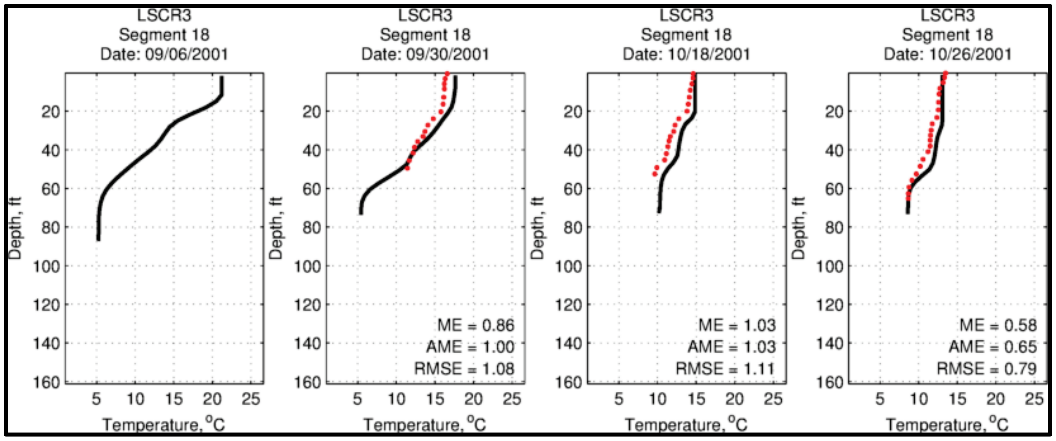


Figure 27. Flow linear and cumulative distribution plots at LSCR11 for CY01 calibration.

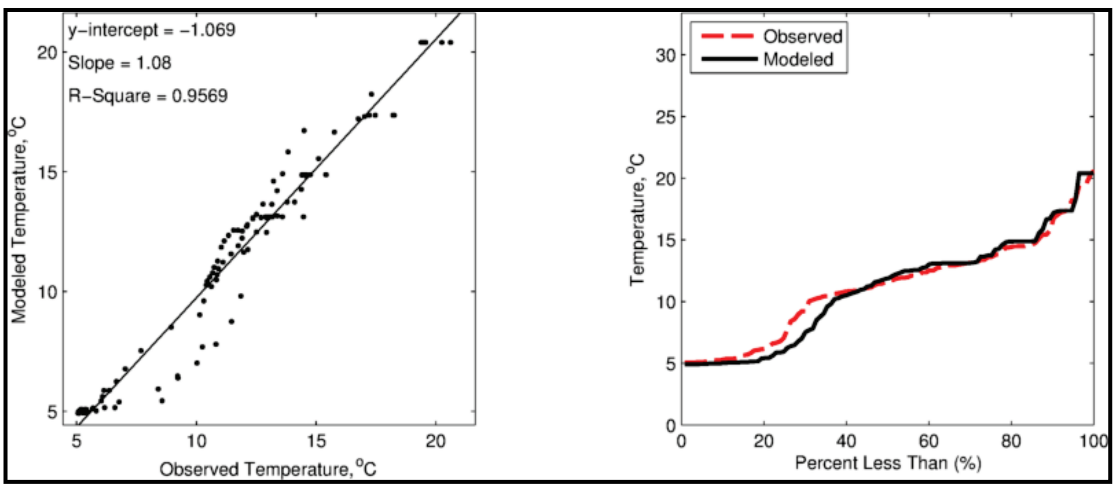


Figure 28. Flow linear and cumulative distribution plots at LSCR9 for CY01 calibration.

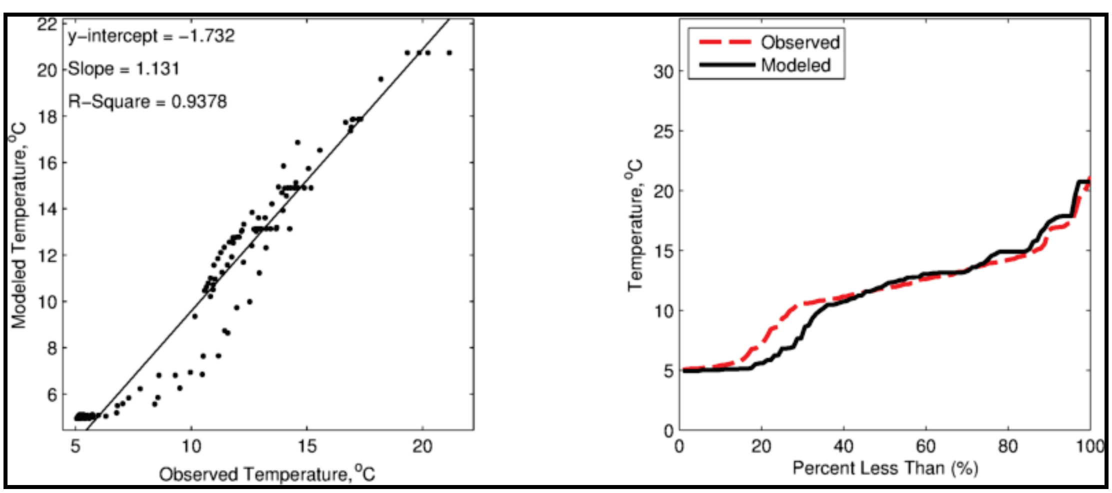


Figure 29. Flow linear and cumulative distribution plots at LSCR3 for CY01 calibration.

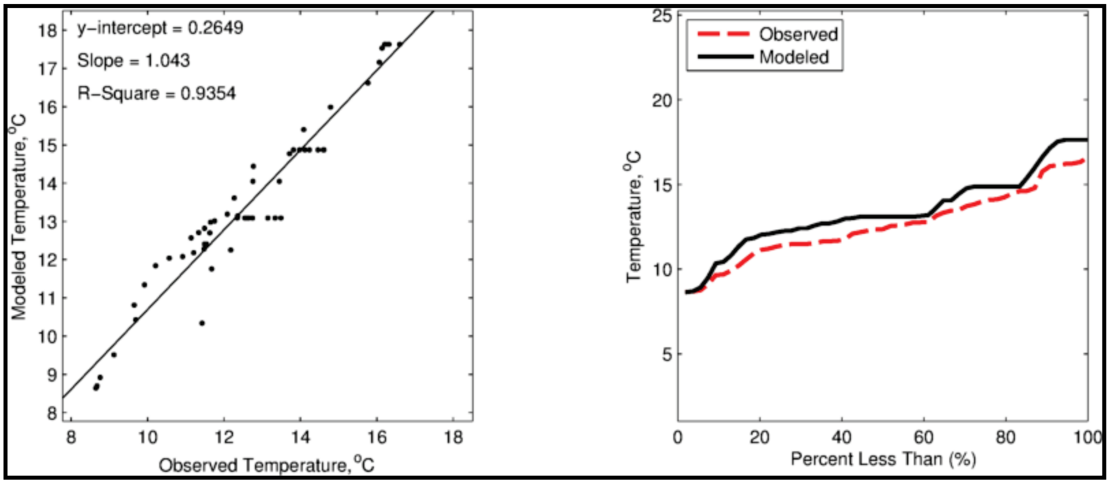
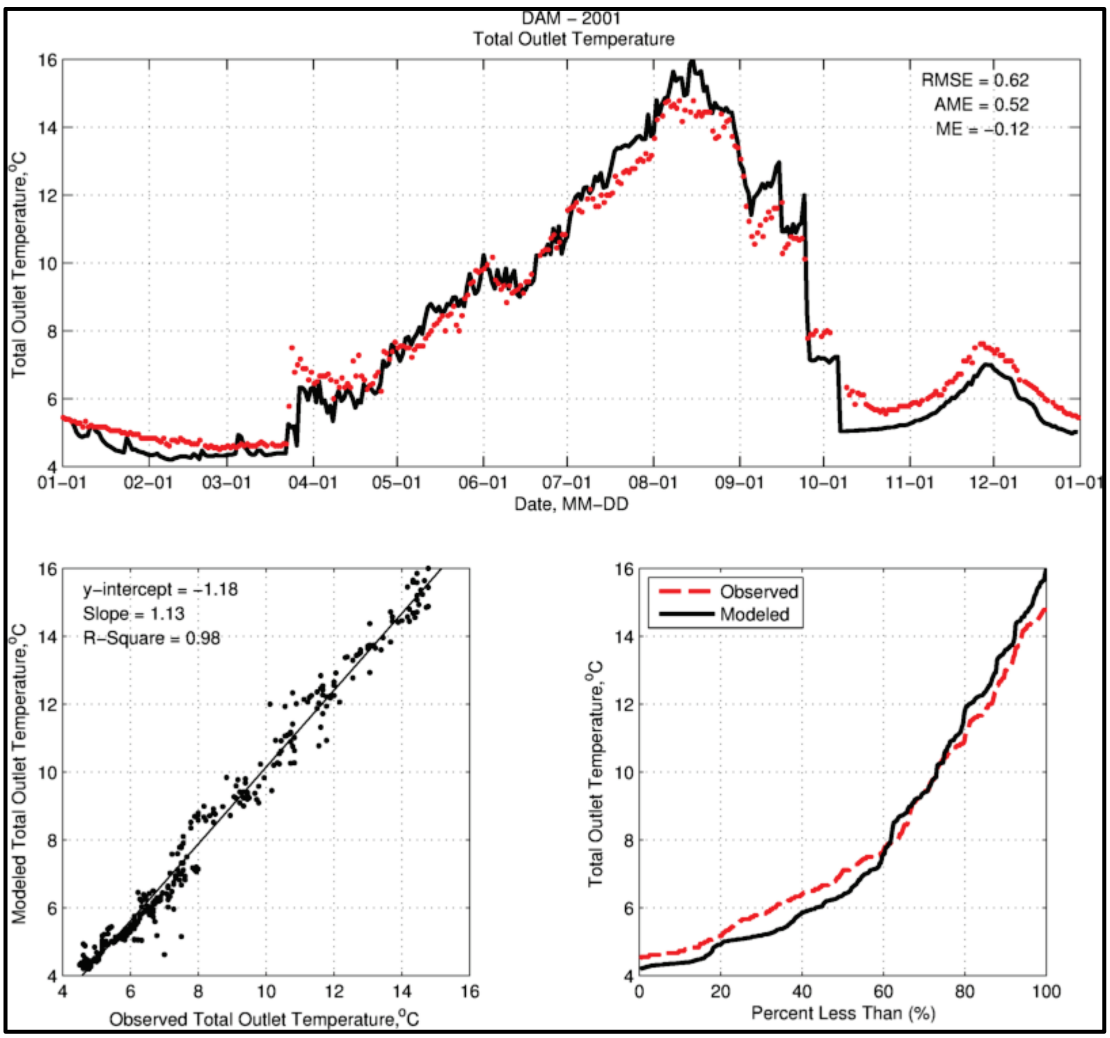


Figure 30. Withdrawal temperature at the dam for CY01 calibration.



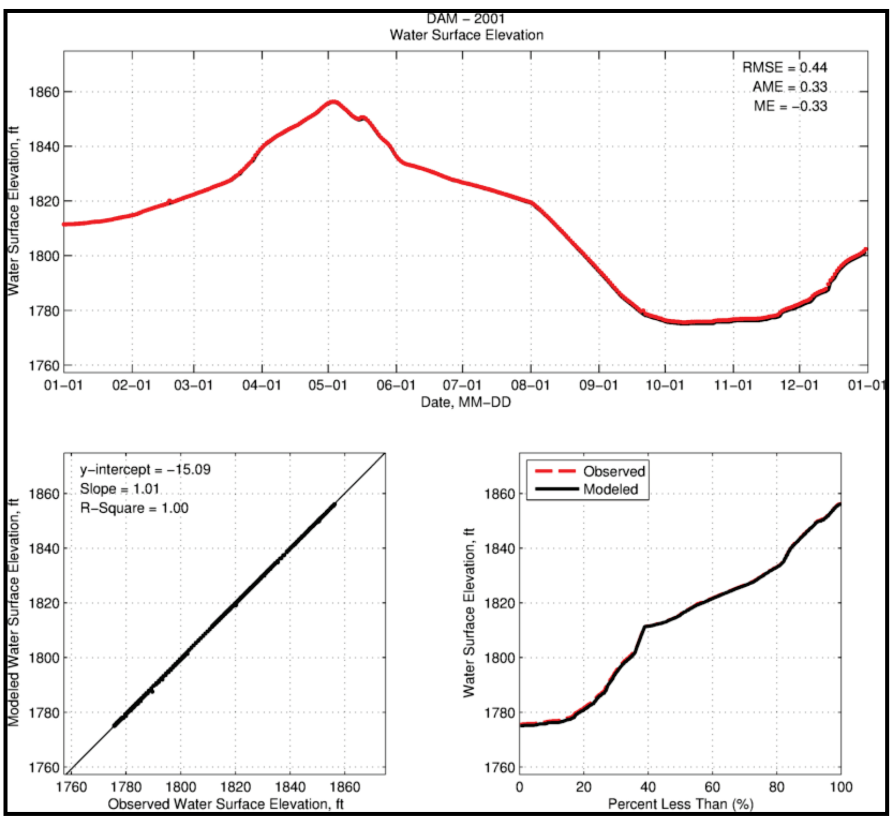
4.3 Water surface elevation

Model output along with observed data for water surface elevations (ELWS) in CY01 at the dam is shown in Figure 31. The AME for all data pairs for 2001 at the dam is 0.33 ft (~0.08 m). Table 7 presents the calculated AME and the 1.64 ft (0.5 m) target that ERDC attempted to reach. The slope of the trendline fitted through the data pairs is 1.01 and the R-squared value is 1.0. Overall, the model only underpredicts ELWS at the dam by 0.33 ft.

Table 7. Basic statistics for water surface elevations (ft) for CY01 calibration.

SITE	Observed Minimum	Observed Maximum	Target AME	AME	ME	Slope	R-Squared
Dam	1775.63	1856.29	1.64	0.33	-0.33	1.01	1.00

Figure 31. Water surface elevations at the dam for CY01 calibration.



5 Calibration Discussion

Model calibration results and all model assumptions are discussed in this section. As stated previously, not only does this report detail graphical comparison, but the authors also present several statistical comparisons: AME, RMSE, and ME. Both the flow results and the temperature results will be discussed below. An inventory of files needed for the calibration runs can be found in Appendix B (Table B2).

5.1 Water surface elevation

As stated previously, due to the water balance instabilities in the model, a distributed tributary was added to the calibration run. This drastically improved the initial results. Figure 32 shows the impact of not using distributed tributary. Notice how the model severely underestimates the water surface elevation for ten months out of the year. By the end of the year, the model has almost 100 ft of elevation worth of unaccounted for water. Once the distributed tributary was added, and before any other parameters were modified, the improvement to the results was astounding (see Figure 33).

Figure 32. Time series and statistical plots of ELWS without the distributed tributary.

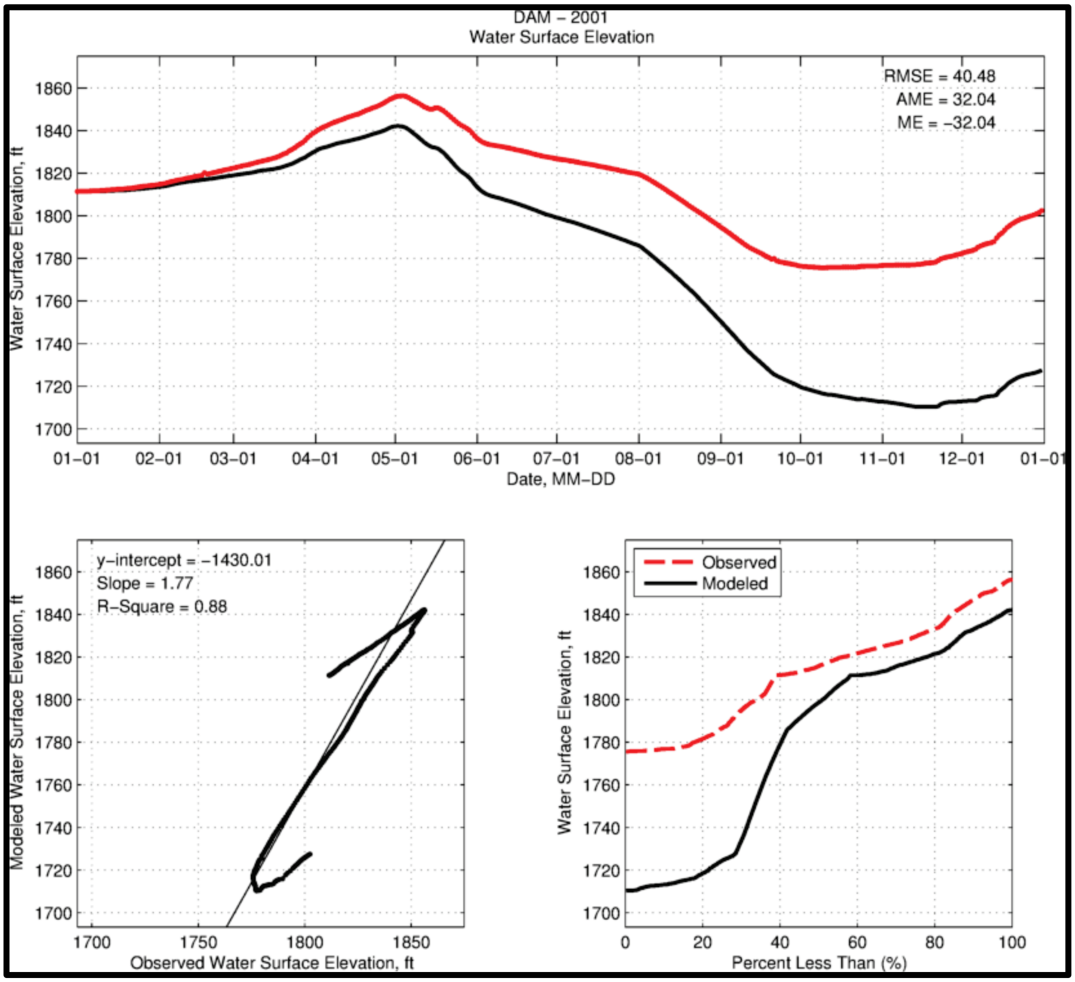
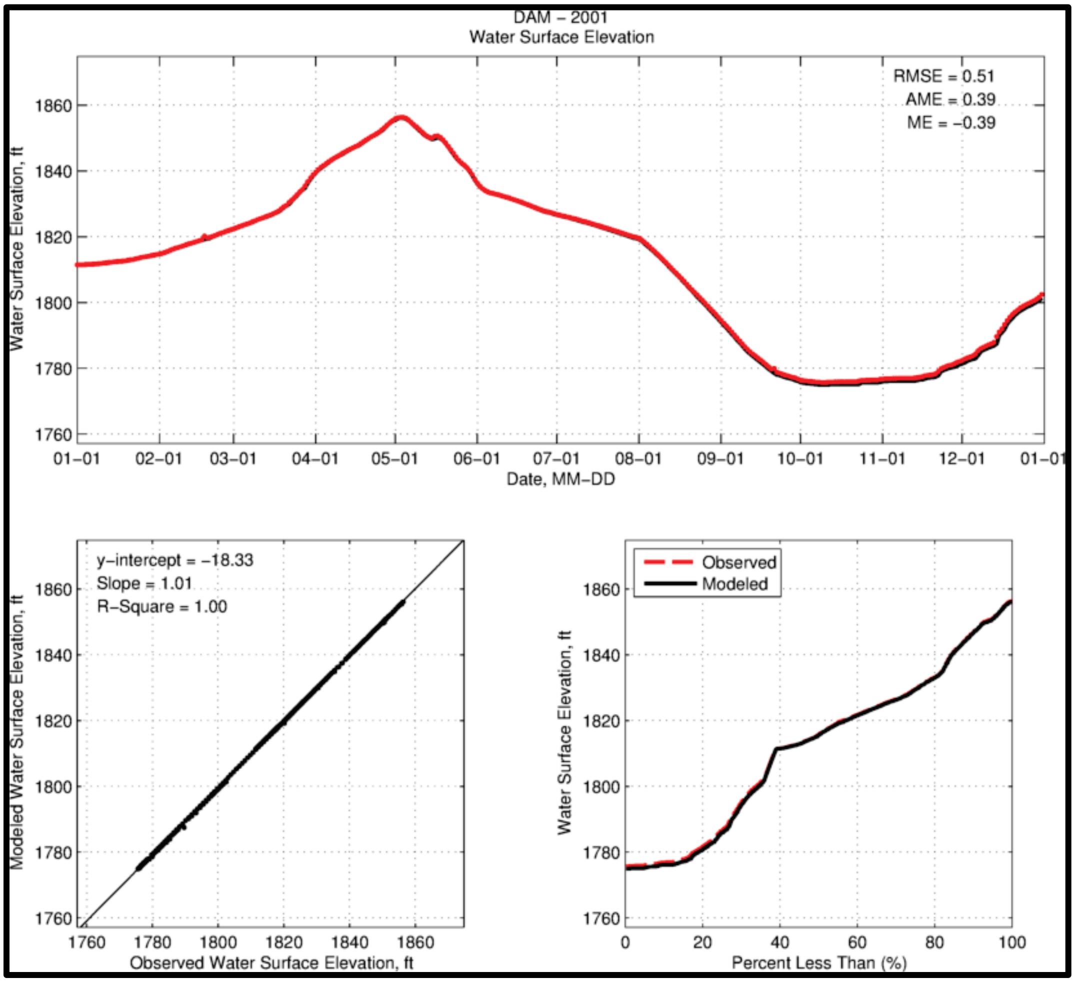


Figure 33. Time series and statistical plots of ELWS with the distributed tributary.



5.2 Temperature

Initially, before the water balance issues were corrected, the model was drastically miscalculating the temperature. However, once the distributed tributary was added, the model was still overpredicting the temperature (CY01-Run02). Upon observing the in-lake profile plots, the surface temperature was too warm. ERDC performed three more simulations with the following changes:

1. Set SROC = OFF in the control file. Due to the fact that the meteorological station is not located at the dam, ERDC has found in previous studies that the model performs better when the W2 is allowed to calculate SRO (short wave solar radiation) internally. Making this change had the most significant effect on the surface temperature. (CY01-Run03 – not plotted below)

2. Changed EXH20 from 0.45 to 0.55 in order to increase the amount of heat retained at the surface instead of letting the heat descend into the water column. After setting SROC = OFF above, although the surface water cooled down significantly, the water was still too warm from 10-50 feet below the surface. Next, the team changed BETA from 0.45 to 0.55. BETA is similar to EXH20 in that it also helps to retain more heat surface. These changes (independent of each other) had a very small positive impact on model temperature predictions. (CY01-Run05 shows these modifications together even though they were run in consecutive runs.)

3. During calibration, the team realized that the outflow for day 267 (September 24th) was incorrect. The values for this day were replaced with the values from the previous day (note the spike in CY01-Run05). Sediment temperature was corrected to average air temperature for the year. Originally, it was 11.5 deg-C. Although this was a very close approximation, the value was corrected to 11.984. (CY01-Run09)

4. The final attempt to improve the in-lake profile temperature predictions was to modify the wind-sheltering coefficient during fall and winter periods when there are no leaves on the trees. This made a significant improvement to model predictions. (CY01-Run13)

Temperature comparisons at the in-lake stations and the dam between each of the runs discussed above are seen in Figure 34-Figure 37. In all of the plots below, the red dots are observed data. The time series comparison is more indicative of the gains in temperature improvement with the above modifications than are the profile comparisons.

Figure 34. Profile comparison at LSCR3.

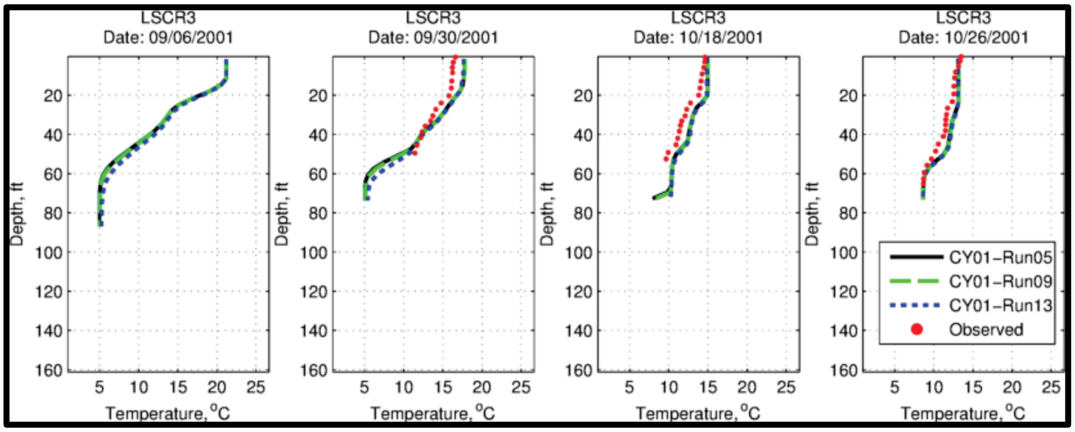


Figure 35. Profile comparison at LSCR9.

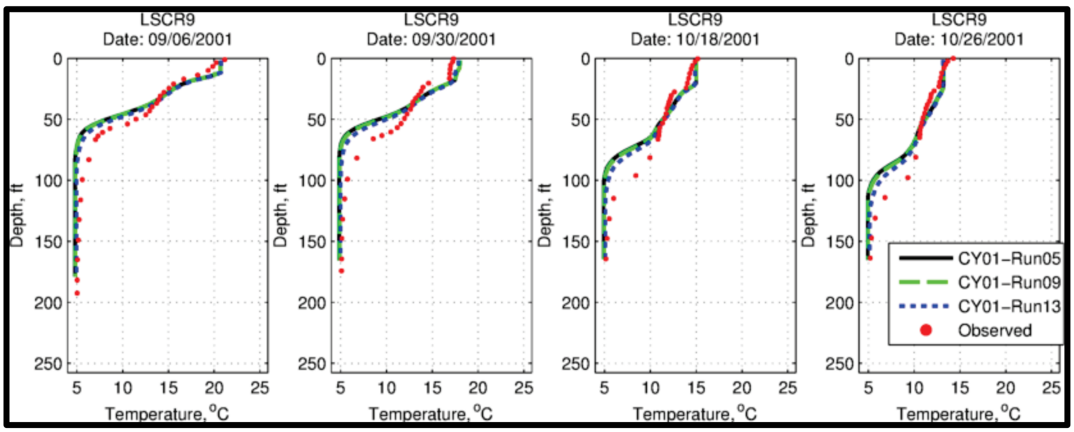


Figure 36. Profile comparison at LSCR11.

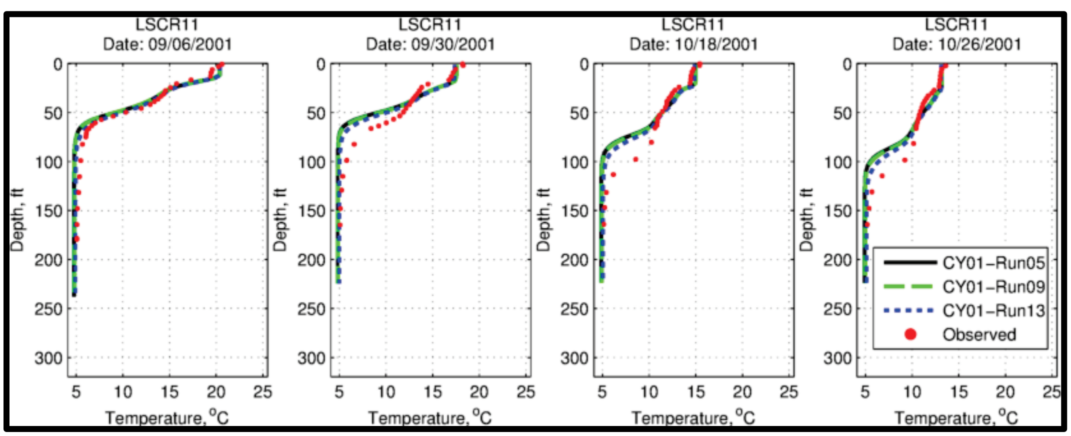
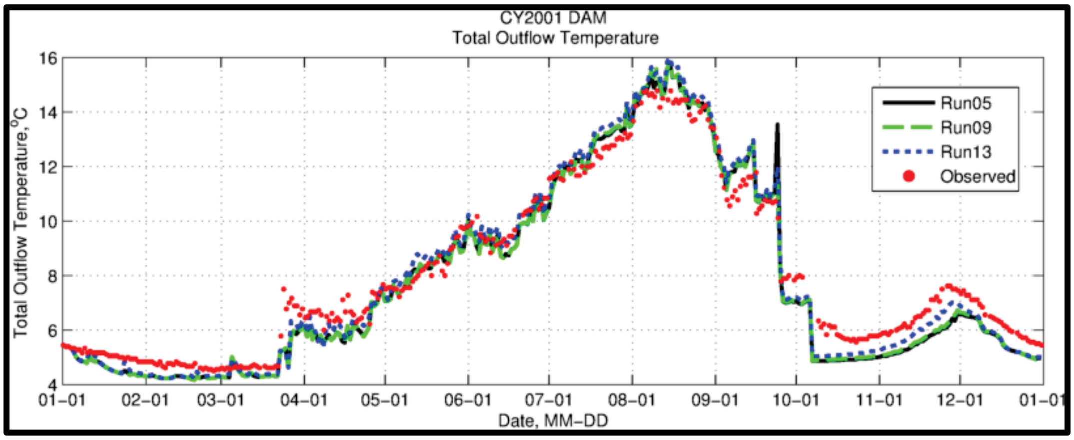


Figure 37. Time series comparison at the dam for CY01.



6 Model Verification – CY03 and CY10

Model verification results are presented in this section. CY03 and 2010 were used because they had the same types of monitored data and similar available in-lake profile data. All of the plots and statistics presented in this section were developed in an identical manner to those in the previous section. Just as for the calibration runs, an inventory of data files can be found in Appendix B (Table B2).

6.1 Flow

Model output along with observed data for CY03 and 2010 at the dam is shown in Figure 38 and Figure 39. Again, this is really just a representation that the data is read correctly from the input outflow file. The AME for all data pairs for 2005 at the dam is 0.08 cfs, which is well less than 0.5% of the measured range of flows for the calendar year. Table 8 presents the 1% AME target that ERDC attempted to reach. The slope of the trendline fitted through the data pairs is 1.00, and the R-squared value is 1.0. Overall, the model only underpredicts outflow at the dam by less than 0.01 cfs.

Table 8. 1% Target for flow (cfs) for CY03 verification.

SITE	Observed Minimum	Observed Maximum	Target AME	AME	ME	Slope	R-Squared
Dam - 2003	800.00	5590.00	47.90	0.19	-0.03	1.00	1.00
Dam - 2010	710.00	5820.00	51.10	0.90	0.68	1.00	1.00

Figure 38. Withdrawal flow at the dam for CY03 verification.

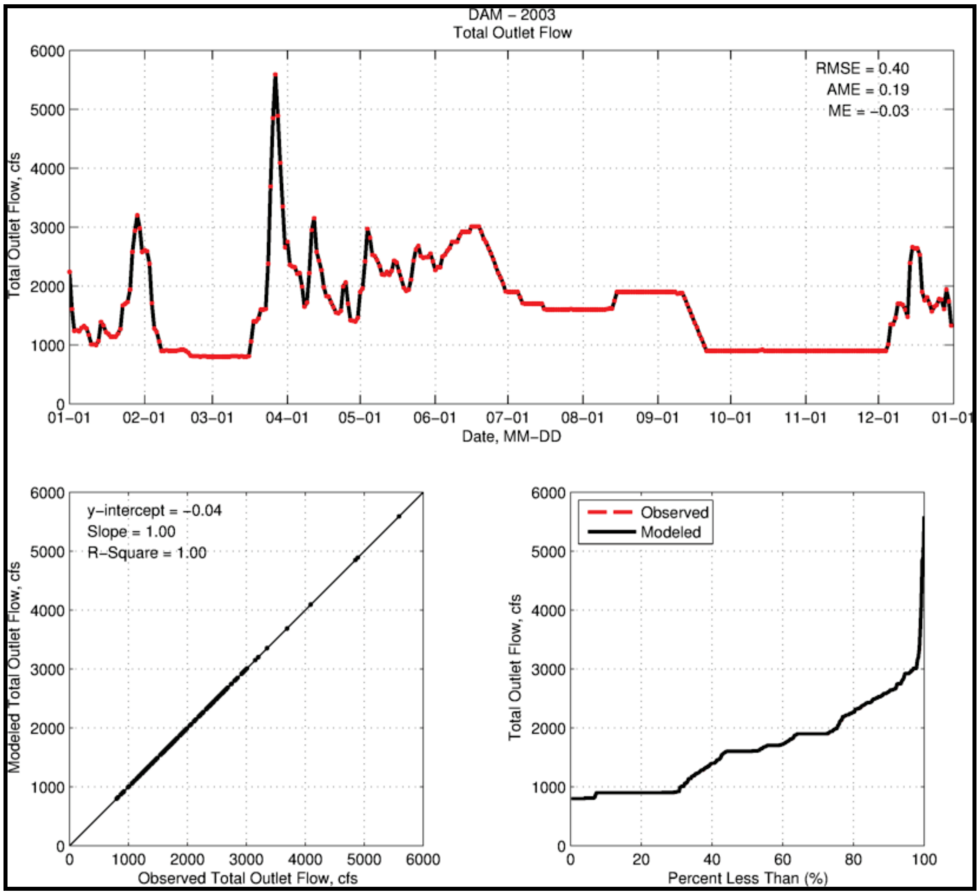
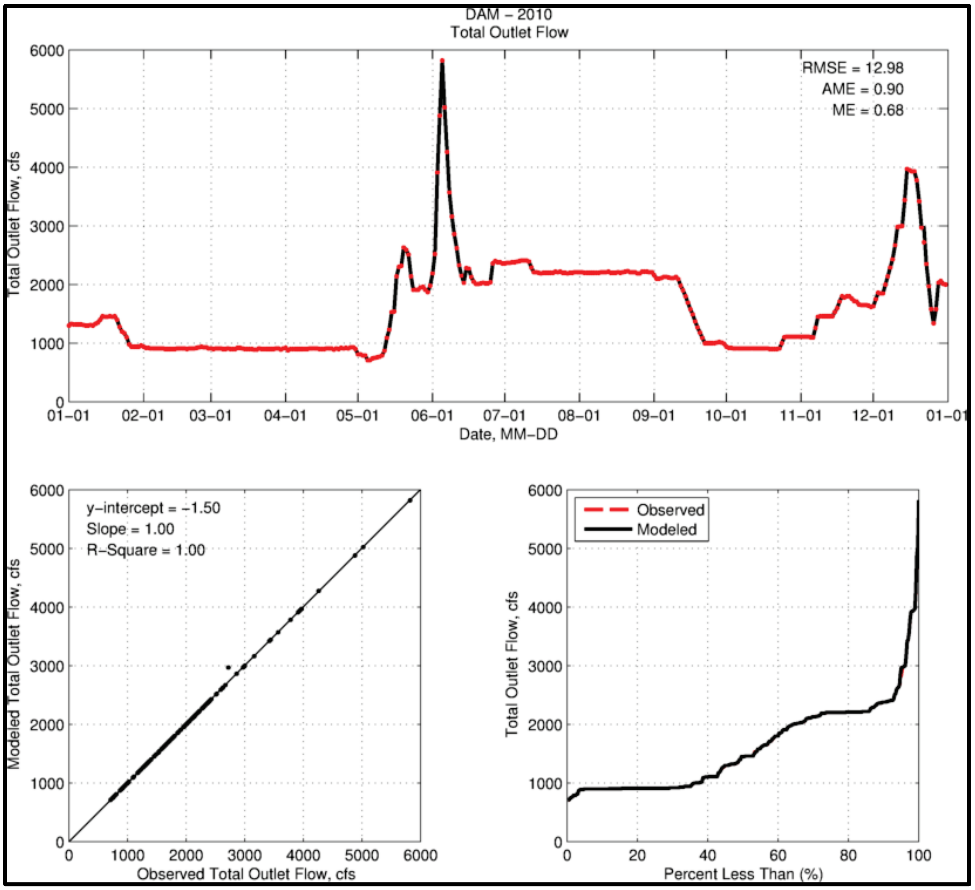


Figure 39. Withdrawal flow at the dam for CY10 verification.



6.2 Temperature

The data available for the verification years was a little different than in CY01. For CY03, only one sample data at one station was available (August 23 at LSCR11). For CY10, no true in-lake stations were monitored. In order to provide feedback on in-lake temperatures, ERDC chose to use temperatures from selected dates available from the temperature string located at the dam (in place since 2006). It is important to note that the temperature string data was only available through May. The 15th day of Jan-May was chosen as representative for each month in CY10. The segments used for data comparison can be found in Table 2.

Profile plots and statistical plots for all in-lake monitoring sites are presented in Figure 40-Figure 43. Time series plots and statistical plots are presented for the dam in Figure 44 (CY03) and Figure 45 (CY10). Table 9 presents the calculated AME and the temperature target that ERDC attempted to reach for the in-lake sites and for the outflow temperature at the dam. The average AME for each of the in-lake sites are within the acceptable target of 1 deg-C. Based on Figure 41 and Figure 43, the average slope of the trendlines is 0.75 and the R-squared value is 0.90 for the in-lake profile site LSCR11 (dam temperature string) for both years. Overall, the model only underpredicts temperature at this site by approximately 0.51 deg-C in CY03 and 0.39 deg-C in CY10. At the dam (temperature string), the AME is 0.47 deg-C and 0.63 deg-C for CY03 and CY10, respectively (see Figure 44 and Figure 45). The model underpredicts temperature by an average of approximately 0.15 deg-C at the dam.

Table 9. Temperature stats (deg-C) for verification years.

SITE	Observed Minimum	Observed Maximum	Target AME	AME	ME	SLOPE	R-squared
LSCR11 (CY03 – one day only)	5.25	23.93	1.00	0.33	-0.25	0.98	0.99
Dam Temp. String (CY10 AVG)	4.51	14.72	1.00	0.53	-0.20	0.51	0.80
Dam (CY03)	4.72	13.50	1.00	0.48	0.06	1.12	0.97
Dam (CY10)	4.89	13.89	1.00	0.64	0.09	1.18	0.96

Figure 40. Temperature profile at LSCR11 in CY03 verification.

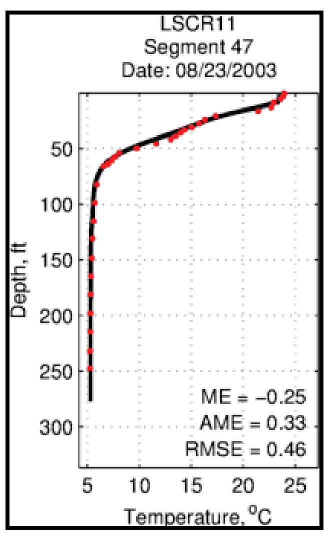


Figure 41. Flow linear and cumulative distribution plots at LSCR11 for CY03 verification.

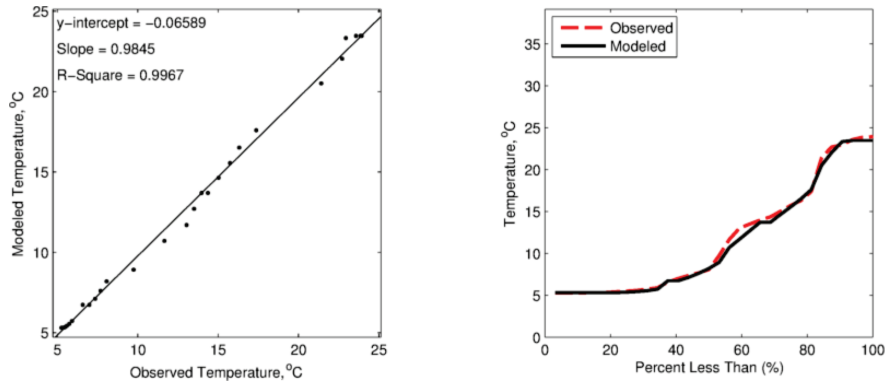


Figure 42. Temperature profiles at the dam temperature string in CY10 verification.

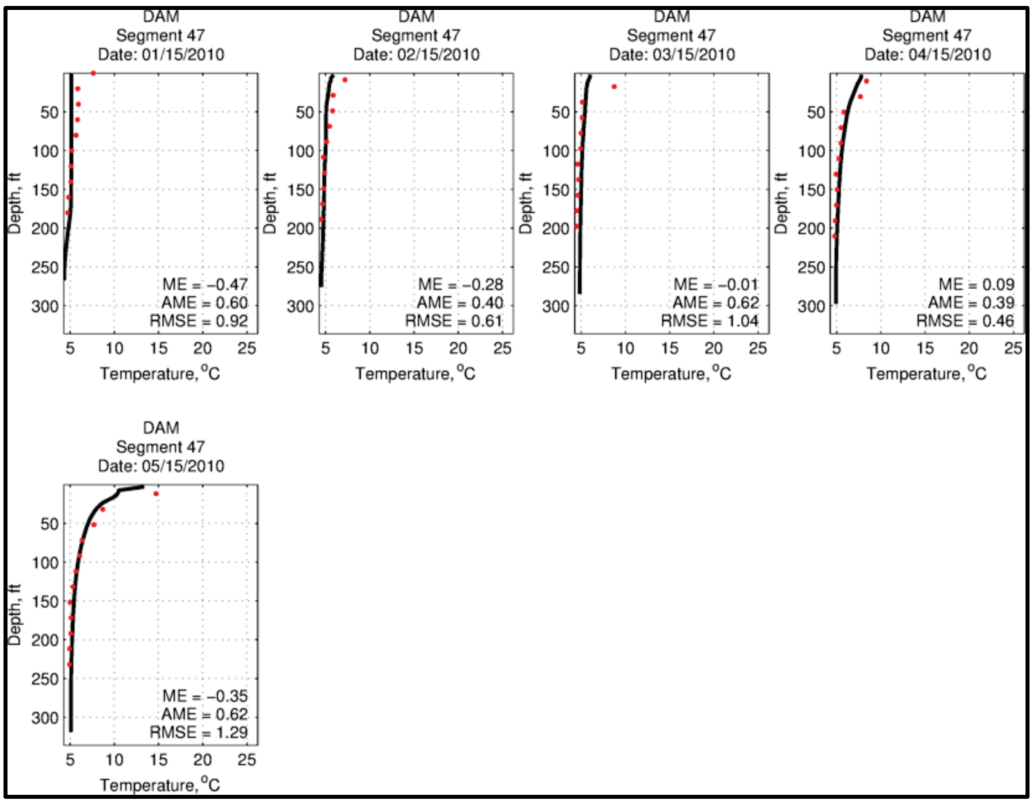


Figure 43. Flow linear and cumulative distribution plots at the dam temperature string for CY10 verification.

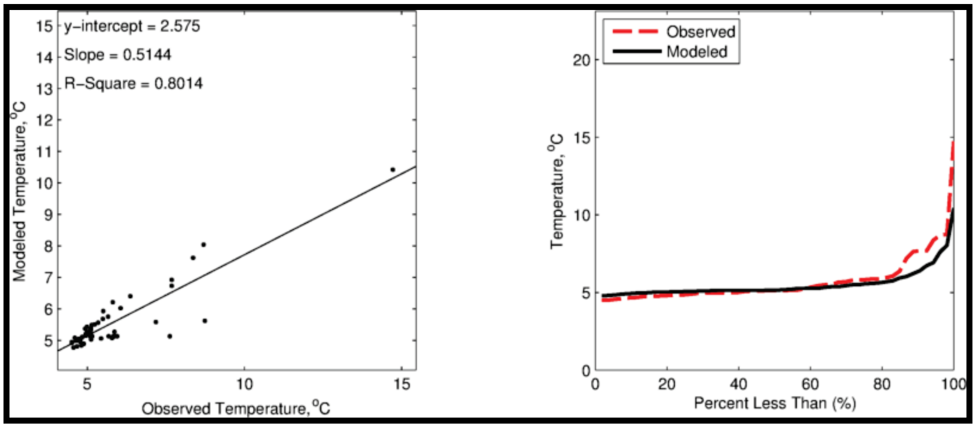


Figure 44. Withdrawal temperature at the dam for CY03 verification.

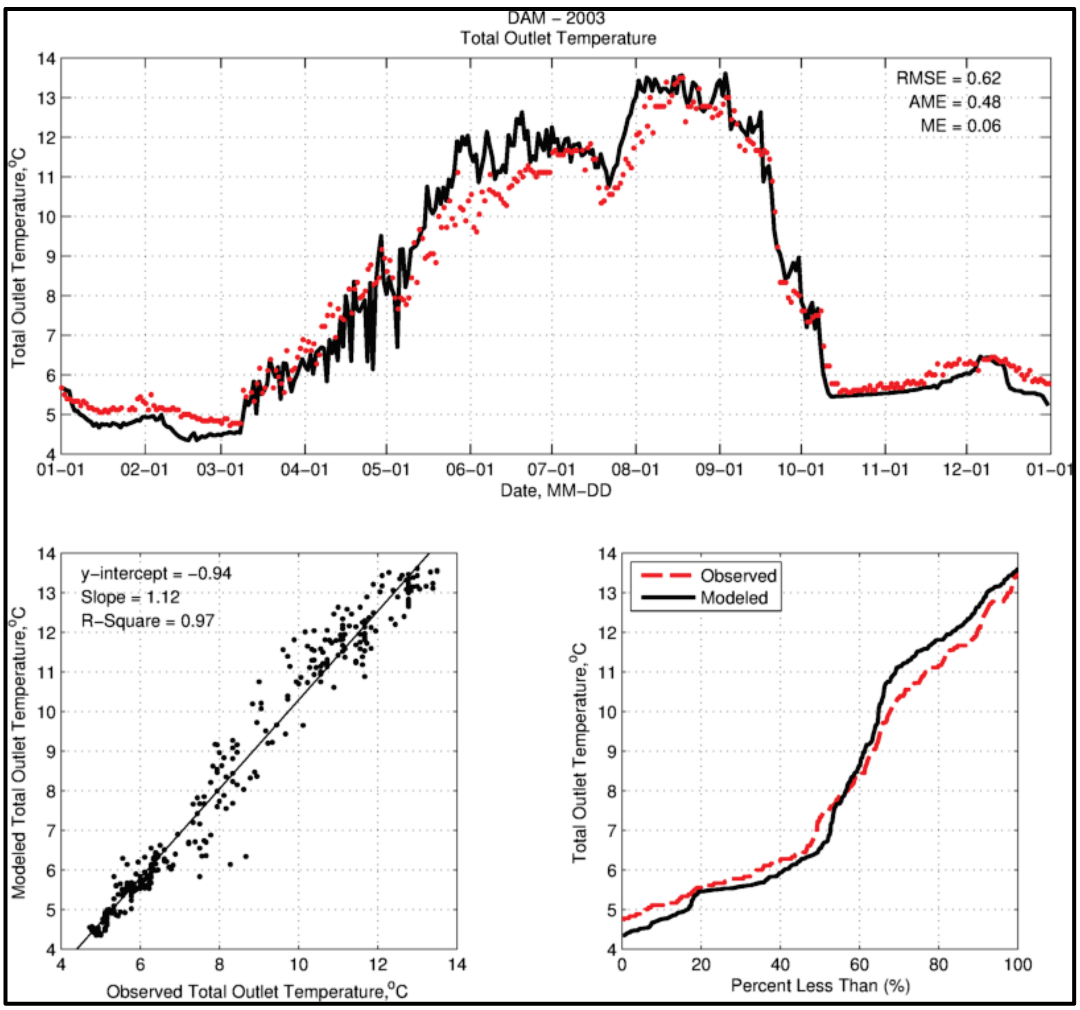
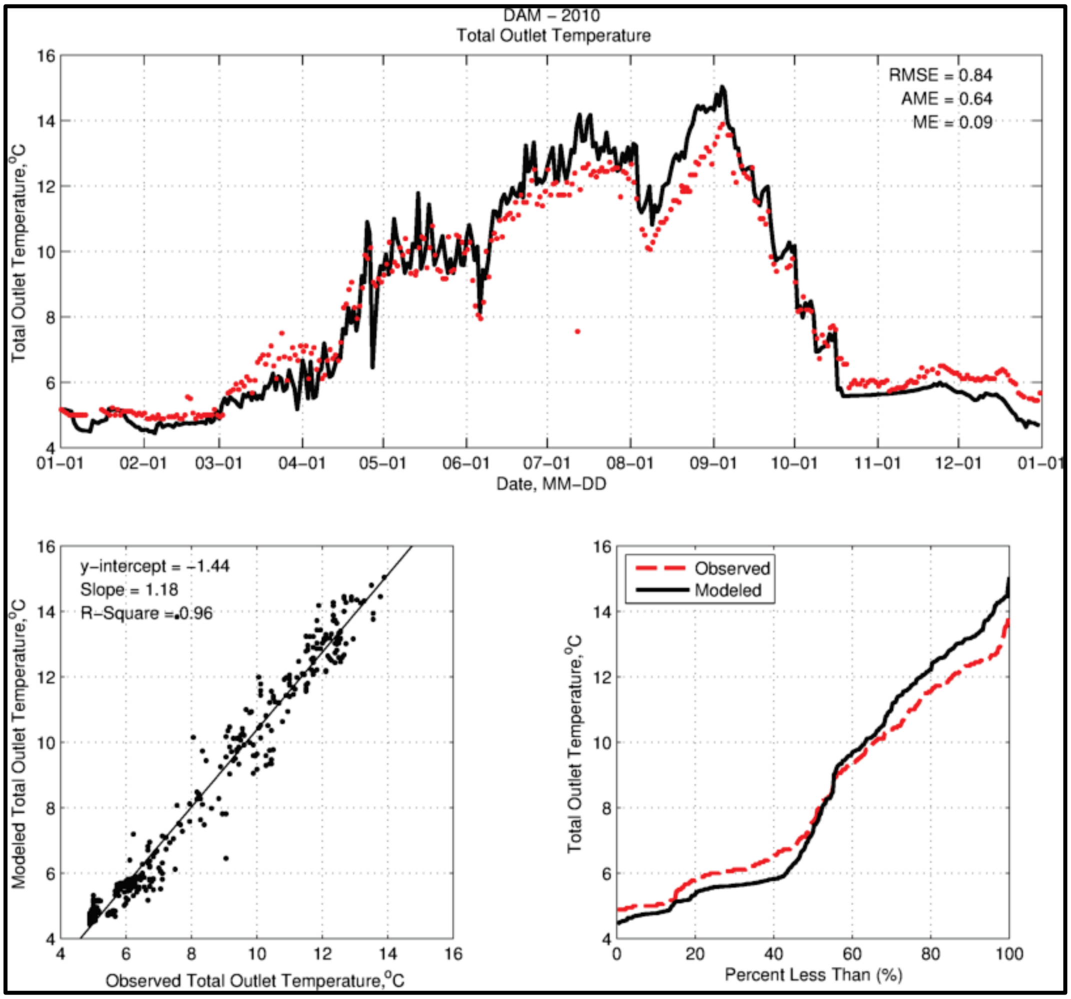


Figure 45. Withdrawal temperature at the dam for CY10 verification.



6.3 Water surface elevation

Model output along with observed data for ELWS CY03 at the dam is shown in Figure 46 and in Figure 47 for CY10. Table 10 presents several stats and lists the target AME for each verification year.

Table 10. Basic statistics water surface elevations (ft) for CY03 verification.

SITE	Observed Minimum	Observed Maximum	Target AME	AME	ME	Slope	R-Squared
Dam (CY03)	1808.78	1872.01	1.64	0.61	-0.48	0.99	1.00
Dam (CY10)	1807.43	1872.60	1.64	0.43	-0.43	1.01	1.00

Figure 46. Water surface elevations at the dam for CY03 verification.

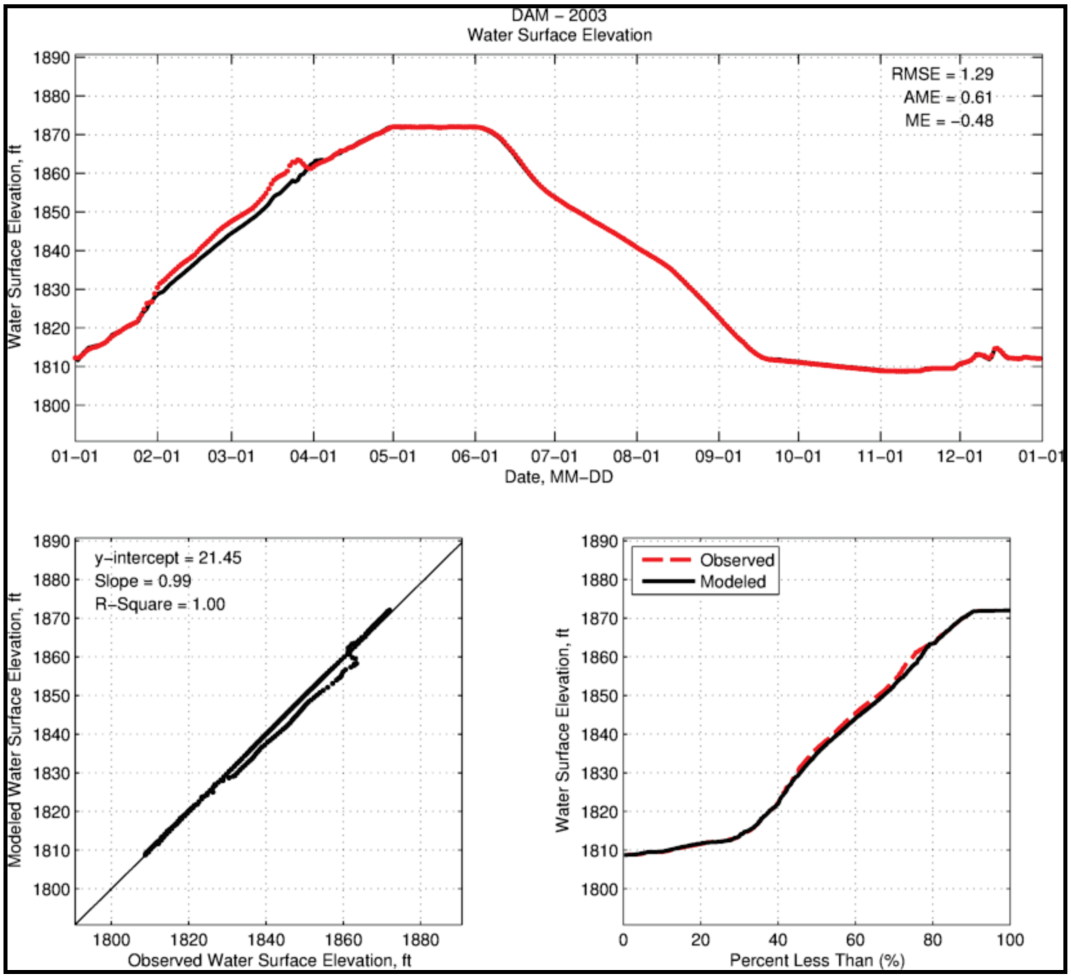
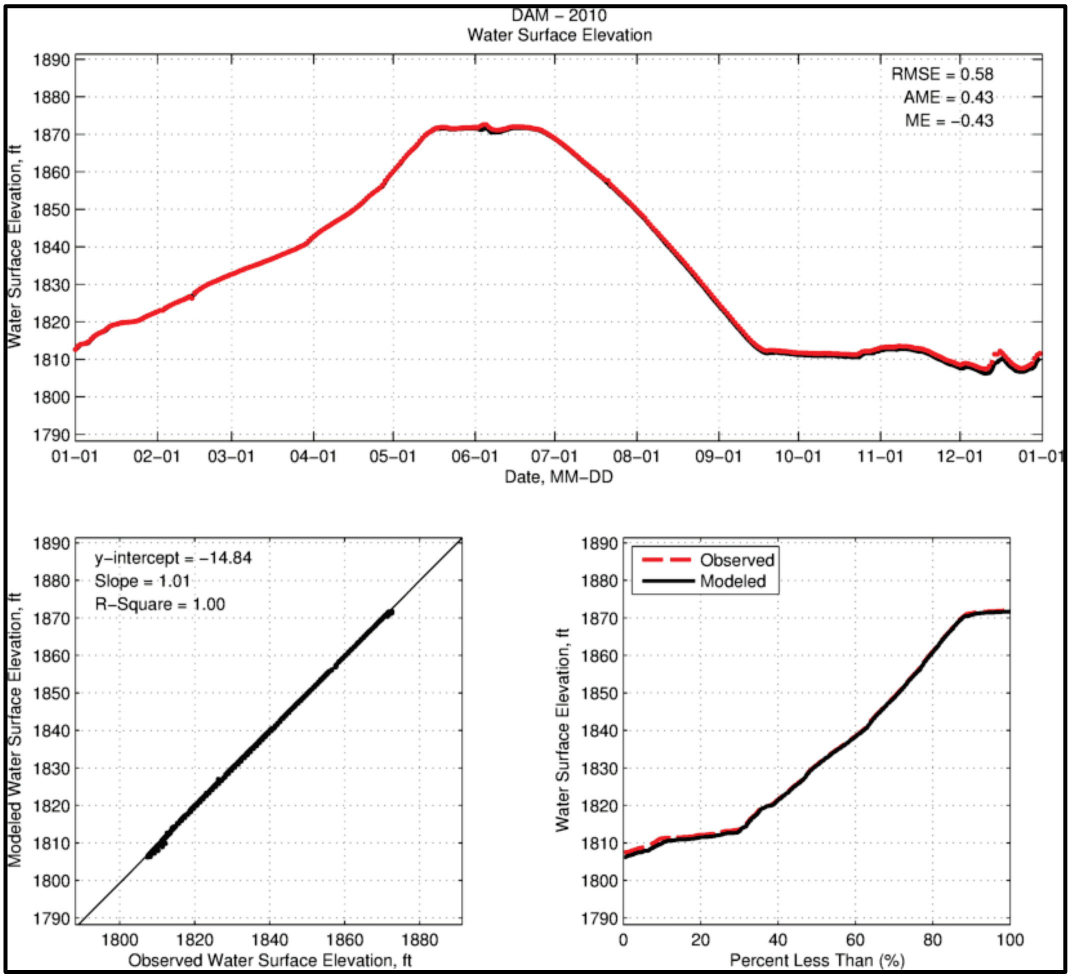


Figure 47. Water surface elevations at the dam for CY10 verification.



7 Verification Discussion

This section serves to discuss the results and the impacts that changes have made on the model runs. Due to the similarity in available input data for each of the verification years compared to the calibration year, no changes were made to the control file. Just as for CY01, a distributed tributary was needed for both calendar years. The water balance utility used to calculate the distributed tributary flow had to be run two times for CY03 due to a sudden increase in the water surface elevations between February and April (see Figure 46). A distributed tributary is utilized in W2 when there is an inconsistent trend with the water balance and when the user can account for missing or too much flow (i.e., ungauged flows). It can be used to add or remove water from the system. In the case of the LCLM, a distributed tributary was used to add water to the system.

To develop a distributed tributary input file, initial model output and observed elevations must be input into the Water Balance Utility developed by Portland State University for use with W2. In the case of the LCLM for CY03, the utility had to be run two times on consecutive runs in order to obtain an acceptable water balance. Additionally, in the event the Water Balance Utility calculated negative flows, these flows were adjusted so that only positive flows were introduced in the model. More information on developing a distributed tributary file can be found in the “Release Notes” that accompany the full W2 download along with the Users’ Manual.

8 Predictive Port Selection Model Application

In order to provide CENWP with the best model to use for operation modifications, the calibrated model was used as a base run to set up a fully predictive model. The model will guide dam operations based on desired temperature targets. The temperature target presented is the bi-weekly target developed by Oregon Department of Fish and Wildlife for 2014 operations. The current version of W2 (v3.71 – 07/15/14) has an algorithm in it to do just this; however, it is limited to only blending temperatures with only two ports at a time. Oftentimes, even the calibration, as previously reported, has three to four ports operating at a time. Upon recommendation from CENWP, ERDC-EL reached out to Stewart Rounds (USGS) to see whether he would be willing to share his version of a less restrictive blending algorithm that is fully integrated with a previous version of W2 (v3.7 from 2012). Mr. Rounds provided ERDC-EL with his code and executables; the results from the USGS version of W2 will be presented in this section. Briefly, the PSU version of W2 results will be discussed as well. An inventory of all files used for each model simulation can be found in Appendix B (Table B3).

8.1 PSU – W2 predictive port selection

PSU's current version of W2 has not fully integrated the algorithm developed by Mr. Rounds at USGS. According to personal correspondence with Dr. Scott Wells (2014), however, it is definitely on the list of model improvements for a future release. W2 is limited to blending temperatures between only two ports. In order to optimize the temperature release, the user must run the model multiple times with minor adjustments (date and temperature adjustments in the w2_selective.npt file). Below are the steps required to run the PSU-Predictive model:

1. Begin with base calibration run for desired year.
2. Place all outflows in topmost port.
3. Run the model with the automatic selection of outlet port control (DYNSTR1 CONTROL) turned ON. This will result in a qwo file that contains information regarding elevation of the withdrawal to get the closest desired temperature.

4. Based on the results from (3) above, create a new QOT input file. Ex: If in the QWO file from (3), flow was specified at the 4th intake port for days 300-365, then in the new QOT file for days 300-365, move the original flow into the column for intake 4.
5. Now turn OFF the DYNSTR1 CONTROL card turned on in (3). Turn ON the SPLIT1 CNTR card. Based on the results from (3), take a best guess on when blending should occur between which ports and update the SPLIT2 cards. Use the desired temperature targets in the TTARGET column.
6. Rerun and plot results. Based on results, modify the SPLIT2 cards as needed and rerun. Repeat this step as necessary.

As one can see, this method is quite cumbersome for the end user. At any point, the user wants to blend between more than 2 ports, more steps have to be repeated. It is a long and tedious task.

Model simulations were run for all years using the PSU version of the code; the results will be presented with the USGS results in the next section.

8.2 USGS – W2 predictive port selection

Detailed information on the development and modifications to the original W2 code can be found in “Improved Algorithms in the CE–QUAL–W2 Water-Quality Model for Blending Dam Releases to Meet Downstream Water-Temperature Targets” (Rounds and Buccola 2015) . Specifics relating to setup of the Lost Creek Lake Predictive Model (LCLPM) will be discussed here. The USGS code uses an iterative process to determine the optimal flows that will produce the desired target temperatures. Of course, this means that the run time will also increase. In the case of the LCLPM, using this code tripled the run time (from about 3-5 minutes to 10-12 minutes).

There were no changes to the main control file from the calibration model (aside from output filename changes). All changes that were made were made in the w2_selective.npt file, which is required when the SELECTC card in the control file is turned ON. Although the structure of the w2_selective.npt file is very similar to the PSU version, there are several new options. The new cards are:

1. TSSHARE: when blending occurs between two ports, having this option ON allows the flows to be best distributed based on desired temperature instead of an even 50-50 split between multiple outlets. (NOTE: For the LCLPM, this was set to ON.)
2. DEPTH: when a non-zero value is input, this allows the model to treat the outlet as a floating outlet. (NOTE: For the LCLPM, DEPTH was set to 0 since Lost Creek Dam consists of fixed ports.)
3. MINFRAC: this specifies the minimum flow rate (when a negative value is entered) or fraction (when a value 0-1 is entered) for a port when that port is active. (NOTE: For the LCLPM, according to the WCM ((USACE 1990), 19% of the flow from the lowest intake is associated with flows at that level. The rest of the flow is assumed to come from the turbidity conduit.)
4. PRIORITY: this specifies the priority for port operations. (NOTE: During various times of the year, CENWP operates to use more surface water sometimes and at other times, the cold lower waters are used. So for the fall and winter months, the priority was shifted to the bottom two ports. Outside of that the priority was to use the topmost port.)
5. MINHEAD: This is the minimum depth in meters for the outlet to be used. (NOTE: Technically, this should be set to 5 m, but since the centerline in the calibration run accounts for the intake roof and minimum head, the ERCD-EL chose not to modify the ESTR card in the W2_control.npt file. With that said, the LCLPM MINHEAD conditions are all set to 0.)
6. MAXHEAD: This is the maximum depth in meters for the outlet to be used. (NOTE: LCLPM MAXHEAD values are set to 0, as well.)
7. MAXFLOW: This is the maximum flow capacity of the port. A zero value indicates no maximum flow criterion. (NOTE: LCLPM values are all set to 0.)

As mentioned above, the minimum head values are accounted for in the specification of the ESTR in the main control file. Since this file was not modified, a MINHEAD was not specified. In the LCLPM w2_selecitve.npt file, the user will find that three split times were identified. The reason these dates were identified is due to operational constraints with seasonal withdrawal depths. Specifying it this way allowed ERDC-EL to set the PRIORITY based on which ports were desired.

The only other caveat that should be mentioned here is that, although only 19% of the flow from the lowest intake is taken at the level, there was no easy way to have the model ONLY use 19% of the flow from here. As the model is set up now with TSSHARE ON and with Intake 4 and the turbidity conduit having the same priority, when flows are taken from either of those ports, a MINIMUM of 19% of the flow will be taken from the total flow. The remaining flow will be split between the two to optimize temperature targets; this results in the fact that more than 19% of the flow is actually taken at the elevation of Intake 4 instead of a hard 19-81% split between the intake and the turbidity conduit.

The user should note that in all of the following plots, the red lines represent a temperature target range. The ODFW targets are used for determining the target values; however, what is represented on the following plots is a target range, which is the ODFW temperature target +/- 1 deg-C, which is a standard measuring error for temperature.

Figure 48 is the w2_selective file used for all of the LCLPM model runs. Figure 49-Figure 59 are plots from CY01 (dry year) that compare the results from the calibration, the results from the PSU-W2 blending algorithm, and the results from the USGS-W2 blending algorithm. Figure 60-Figure 70 represent the same plots for CY03 (normal year), and Figure 71-Figure 81 represent CY10 (wet year). As one can see, the outflow temperatures are fairly consistent between the two blending algorithms; however, the flows and the releases are drastically different at times. Figure 82 shows the average percentage of model-predicted temperatures that fall within the desired target range. As one can see, the USGS algorithm produces better results more often than the calibration run and more often than the multi-step PSU version. To save the user multiple runs for the predictive mode model, ERDC-EL suggests that the USGS algorithm be used.

Figure 48. W2_Selective.NPT file used for the LCLPM.

```
W2_SELECTIVE.NPT

Selective input control file - LCL-CY01 USGS PortRun13
Temperature outlet control - frequency of output for temperature
OUT FREQ TFRQTMP
           1.000
Structure outlet control based on time and temperature and branch
DYNSTR1  CONTROL     NUM    FREQ
             OFF       1    0.50

DYNSTR2    ST/WD      JB   JS/NW  YEARLY    TSTR    TEND    TEMP   NELEV   ELEV1   ELEV2   ELEV3   ELEV4   ELEV5
1             ST       1       1      ON     1.0    46.0     3.3       5 564.642 547.878 529.590 502.158 488.442

MONITOR LOC ISEG    ELEV  DYNCEL
1              0    -1.0     OFF

AUTO ELEVCONTROL
1             ON

SPLIT1      CNTR     NUM  TSFREQ  TSCONV
              ON       3   0.250   0.005

SPLIT2     ST/WD      JB  YEARLY    TSTR    TEND TTARGET  DYNSEL  ELCONT   NOUTS TSSHARE
1             ST       1      ON     1.0    60.0     3.0      ON     OFF       5      ON
2             ST       1      ON    60.1   274.0     3.0      ON     OFF       5      ON
3             ST       1      ON   274.1   366.0     3.0      ON     OFF       5      ON

SPLITOUT JS1/NW1 JS2/NW2 JS3/NW3 JS4/NW4 JS5/NW5 JS6/NW6 JS7/NW7 JS8/NW8 JS9/NW9 JS0/NW0
1              1       2       3       4       5
2              1       2       3       4       5
3              1       2       3       4       5

DEPTH     DEPTH1  DEPTH2  DEPTH3  DEPTH4  DEPTH5  DEPTH6  DEPTH7  DEPTH8  DEPTH9 DEPTH10
1              0       0       0       0       0
2              0       0       0       0       0
3              0       0       0       0       0

MINFRAC  MINFRC1 MINFRC2 MINFRC3 MINFRC4 MINFRC5 MINFRC6 MINFRC7 MINFRC8 MINFRC9 MNFRC10
1              0       0       0    0.19    0.00
2              0       0       0    0.19    0.00
3              0       0       0    0.19    0.00

PRIORITY  PRIOR1  PRIOR2  PRIOR3  PRIOR4  PRIOR5  PRIOR6  PRIOR7  PRIOR8  PRIOR9 PRIOR10
1              4       3       2       1       1
2              1       2       3       4       4
3              4       3       2       1       1

MINHEAD   MINHD1  MINHD2  MINHD3  MINHD4  MINHD5  MINHD6  MINHD7  MINHD8  MINHD9 MINHD10
1              0       0       0       0       0
2              0       0       0       0       0
3              0       0       0       0       0

MAXHEAD   MAXHD1  MAXHD2  MAXHD3  MAXHD4  MAXHD5  MAXHD6  MAXHD7  MAXHD8  MAXHD9 MAXHD10
1              0       0       0       0       0
2              0       0       0       0       0
3              0       0       0       0       0

MAXFLOW  MAXFLO1 MAXFLO2 MAXFLO3 MAXFLO4 MAXFLO5 MAXFLO6 MAXFLO7 MAXFLO8 MAXFLO9 MXFLO10
1              0       0       0       0       0
2              0       0       0       0       0
3              0       0       0       0       0

THRESH1    TEMPN
              12

THRESH2 TEMPCRIT
1           4.50
2           5.30
3           5.30
4           6.75
5           8.65
6          12.00
7          14.25
8          14.00
9          12.30
10          8.95
11          6.45
12          5.00
```

(**NOTE: ELEV6-10 are cut off for better image clarity. These values are blank since there are only 5 ports.)

Figure 49. CY01 - LCLPM temperature comparison with target temperatures.

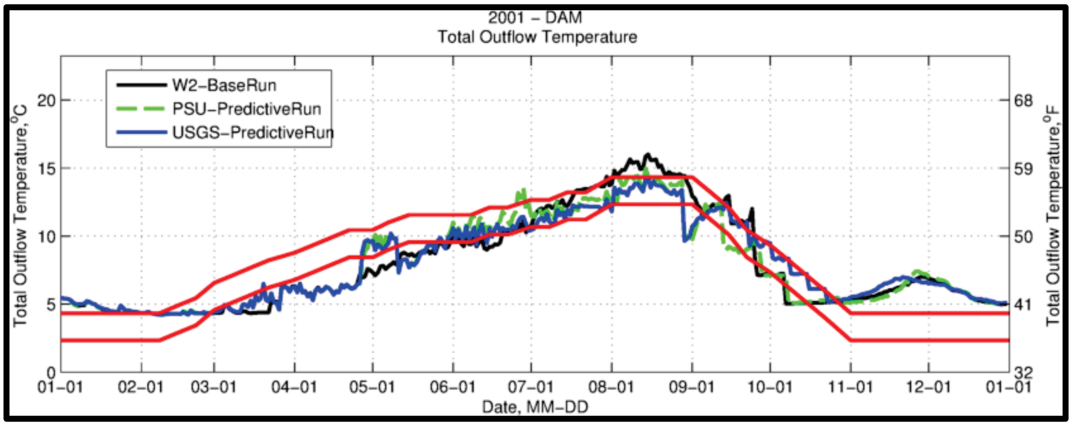


Figure 50. CY01 - Intake 1 - temperature into tower.

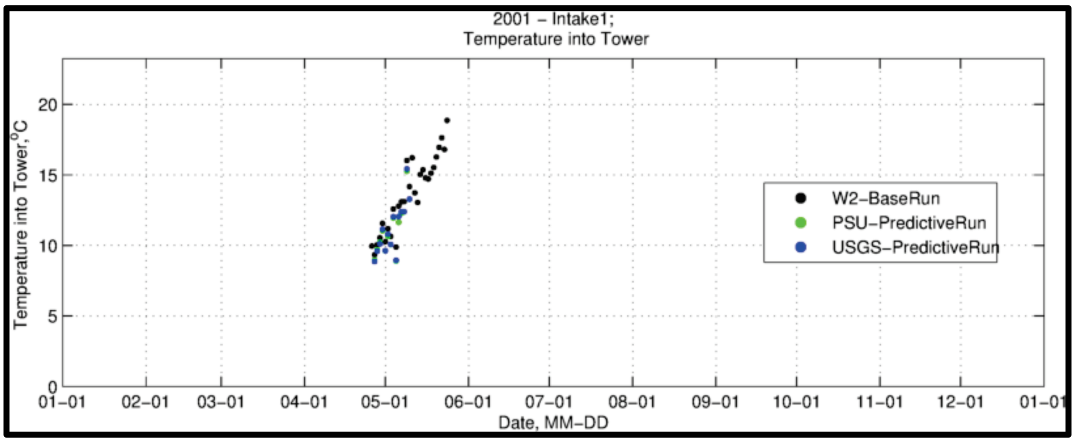


Figure 51. CY01 - Intake 2 - temperature into tower.

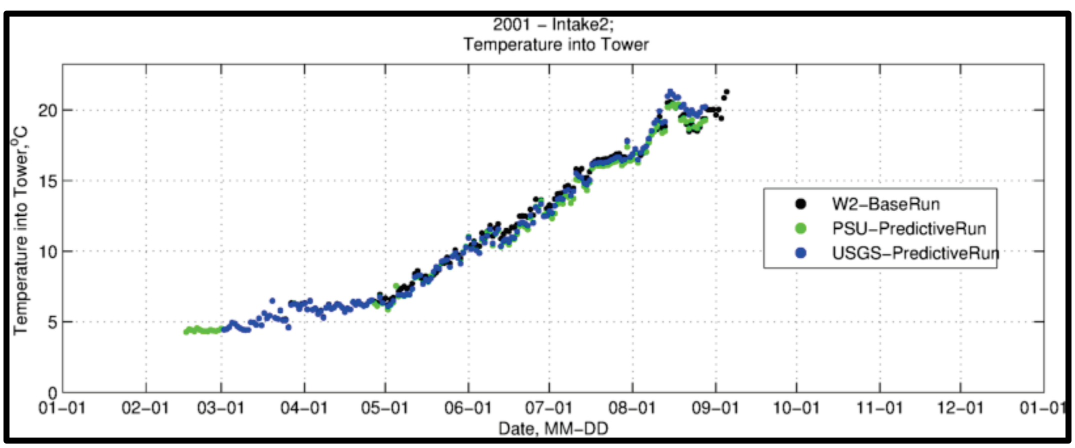


Figure 52. CY01 - Intake 3 - temperature into tower.

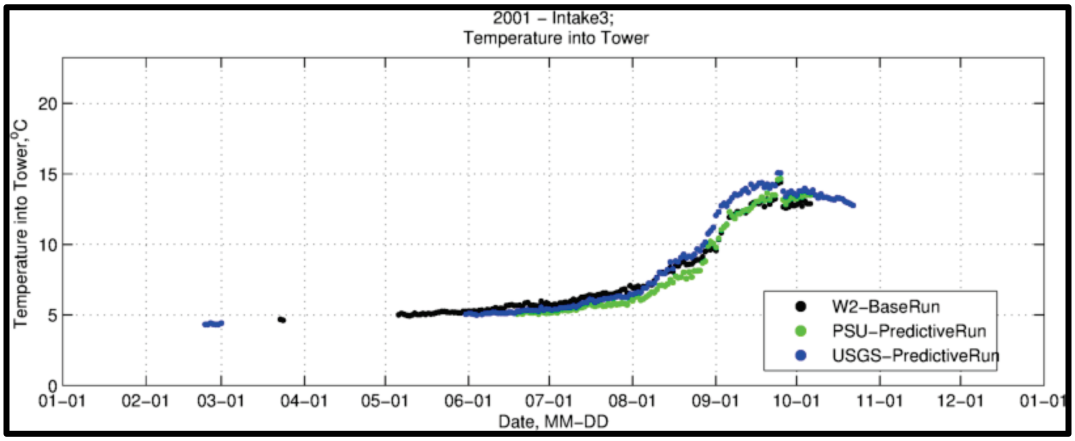


Figure 53. CY01 - Intake 4 - temperature into tower.

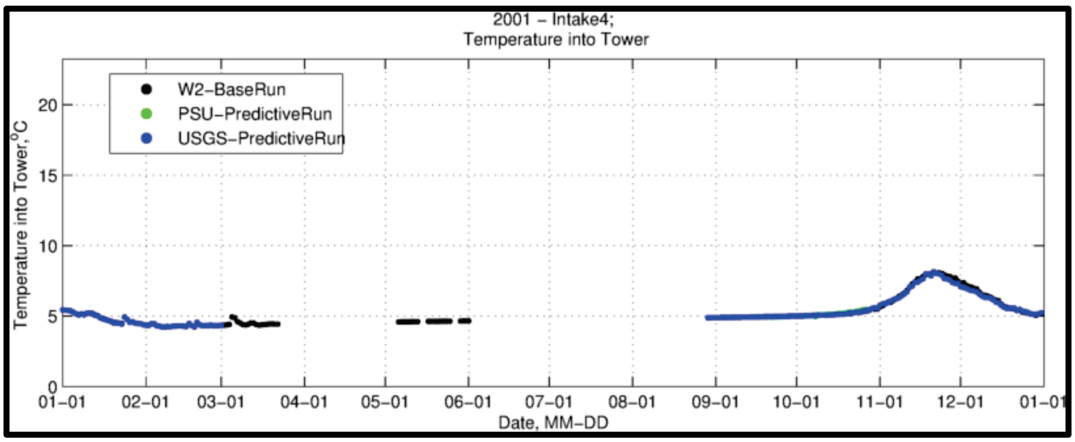


Figure 54. CY01 - Turbidity conduit - temperature into tower.

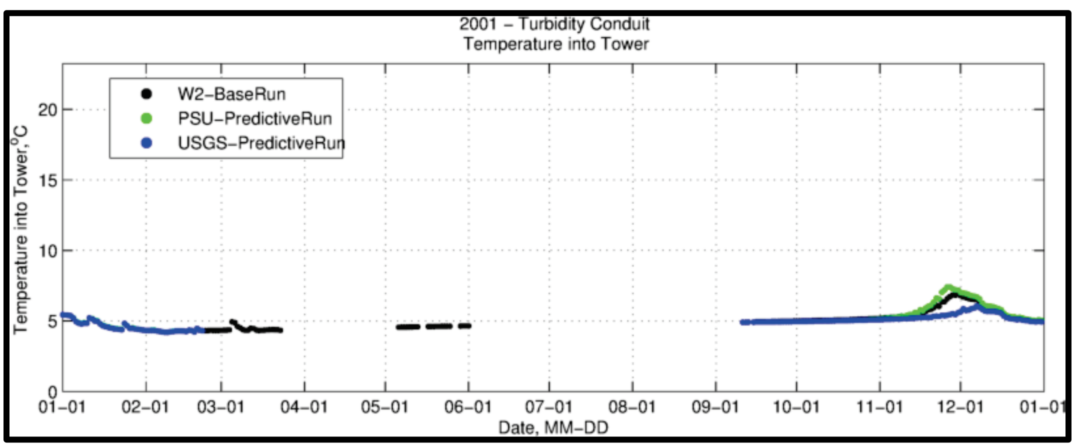


Figure 55. CY01 - Intake 1 - flow into tower.

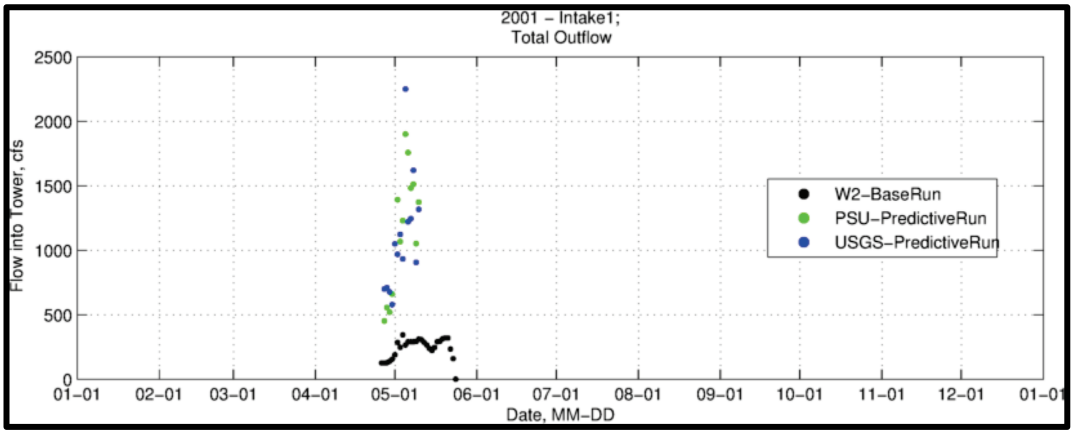


Figure 56. CY01 - Intake 2 - flow into tower.

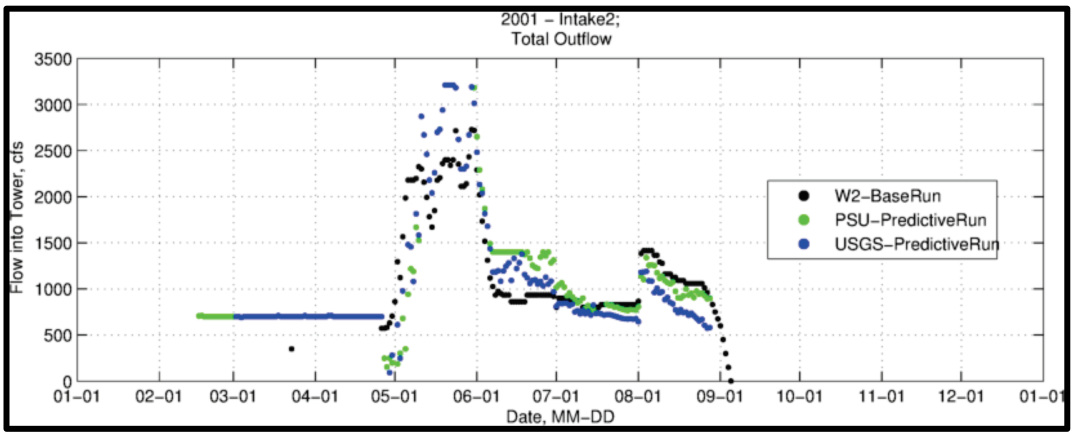


Figure 57. CY01 - Intake 3 – flow into tower.

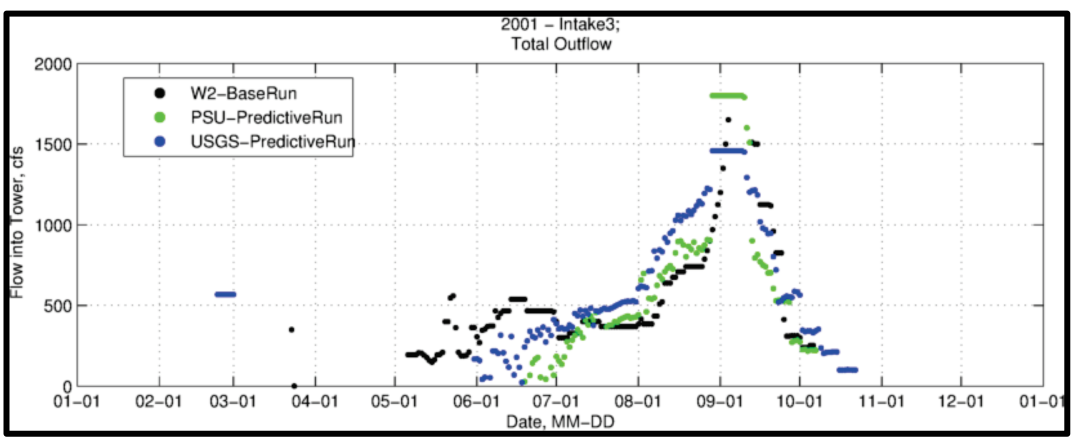


Figure 58. CY01 - Intake 4 - flow into tower.

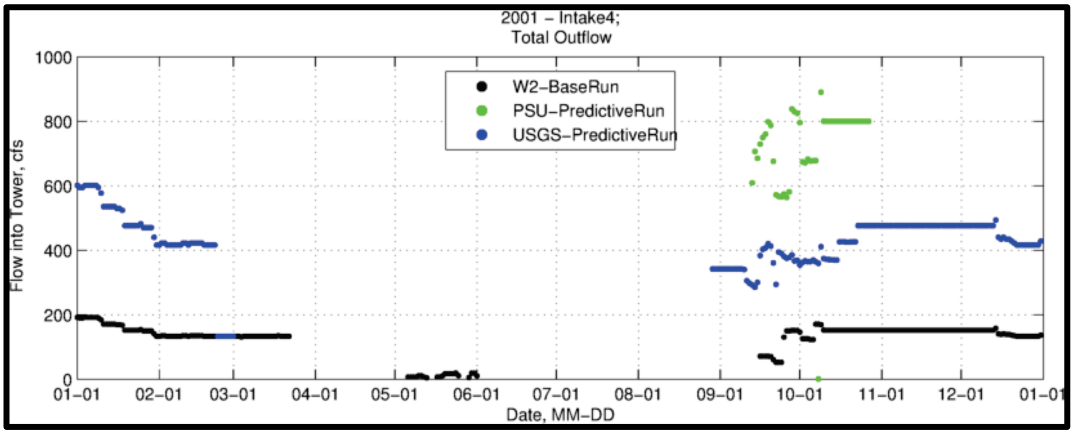


Figure 59. CY01 - Turbidity conduit - flow into tower.

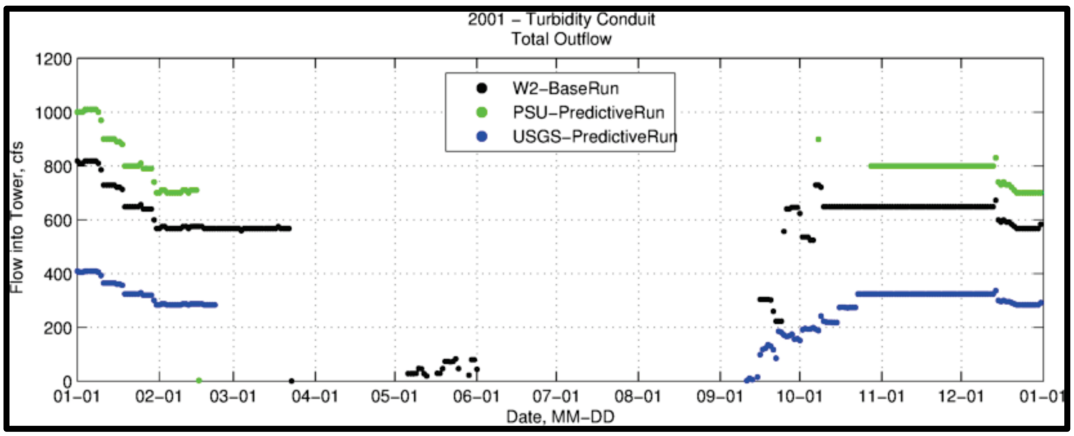


Figure 60. CY03 - LCLPM temperature comparison with target temperatures.

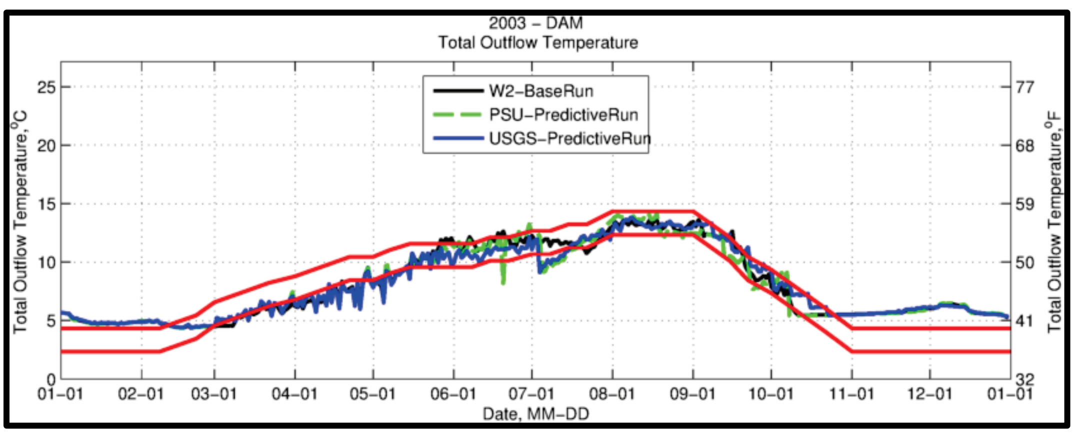


Figure 61. CY03 - Intake 1 - temperature into tower.

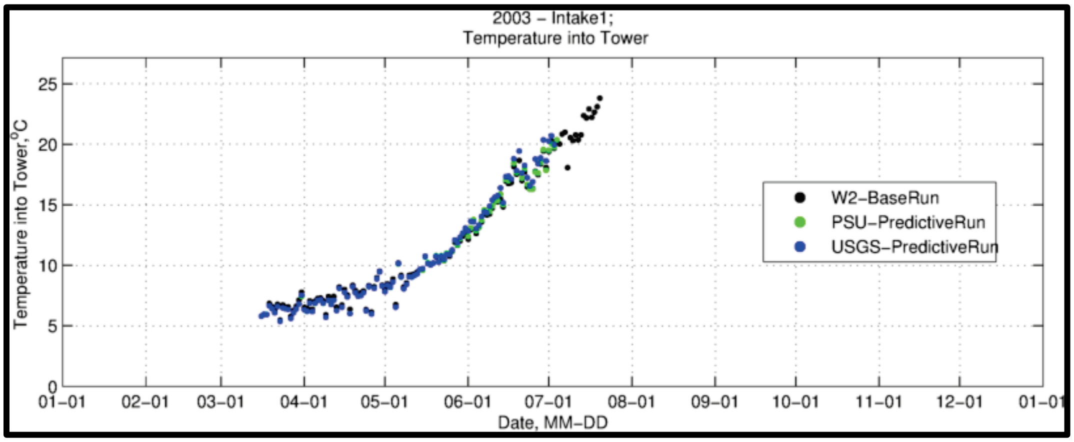


Figure 62. CY03 - Intake 2 - temperature into tower.

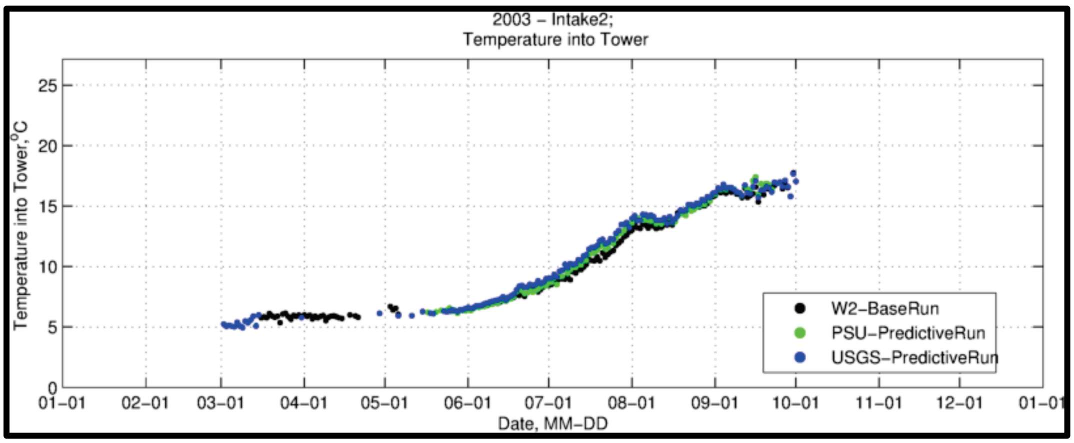


Figure 63. CY03 - Intake 3 - temperature into tower.

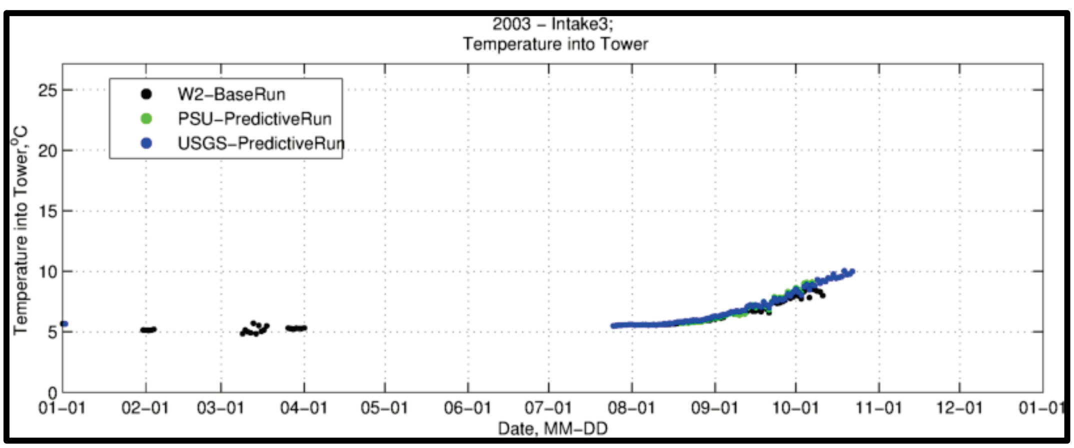


Figure 64. CY03 - Intake 4 - temperature into tower.

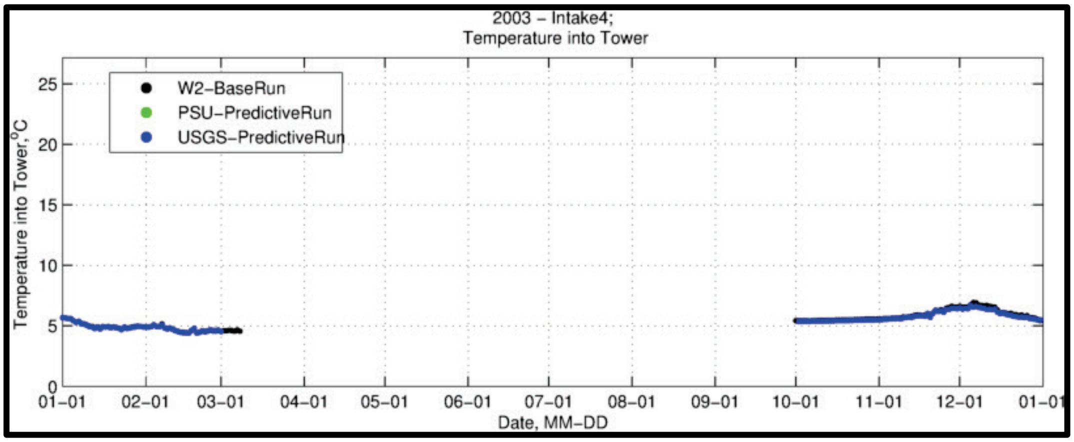


Figure 65. CY03 - Turbidity conduit - temperature into tower.

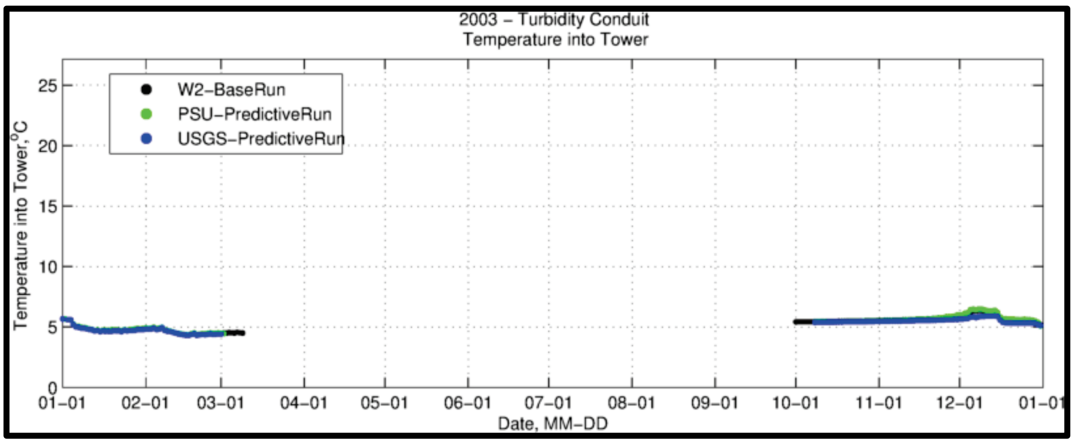


Figure 66. CY03 - Intake 1 - flow into tower.

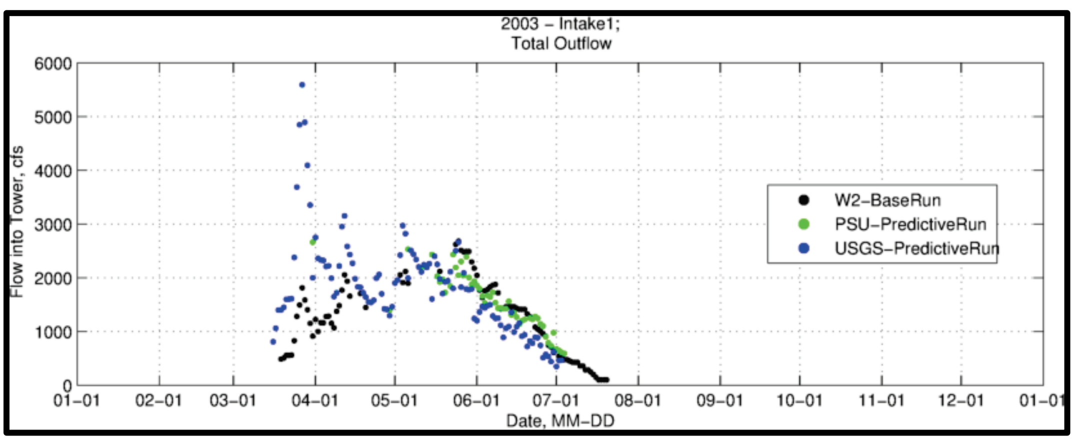


Figure 67. CY03 - Intake 2 - flow into tower.

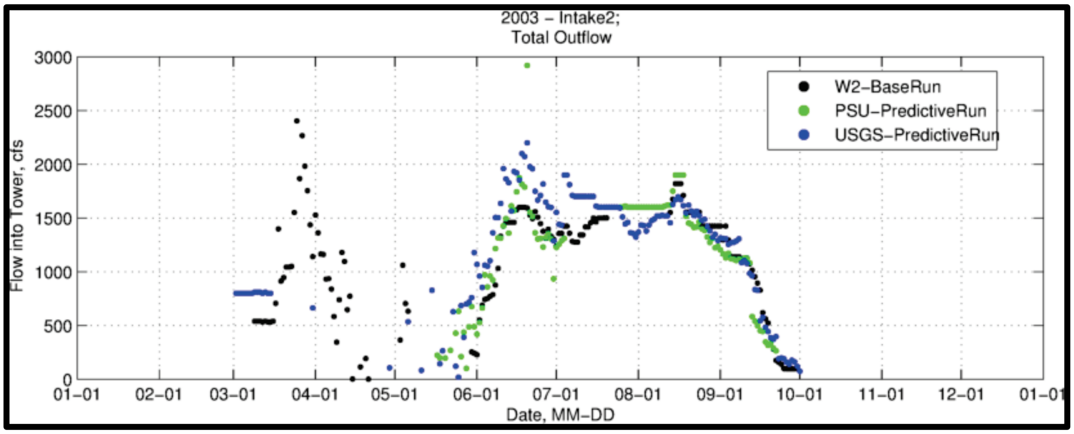


Figure 68. CY03 - Intake 3 - flow into tower.

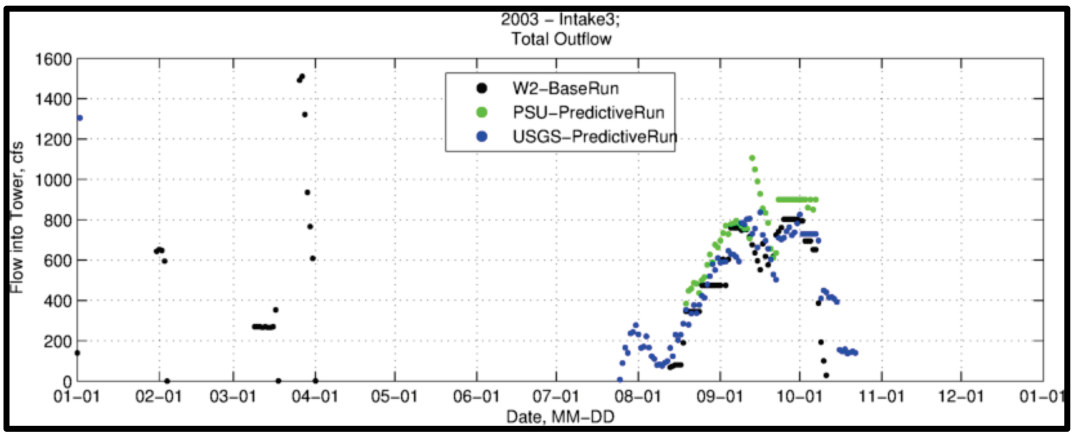


Figure 69. CY03 - Intake 4 - flow into tower.

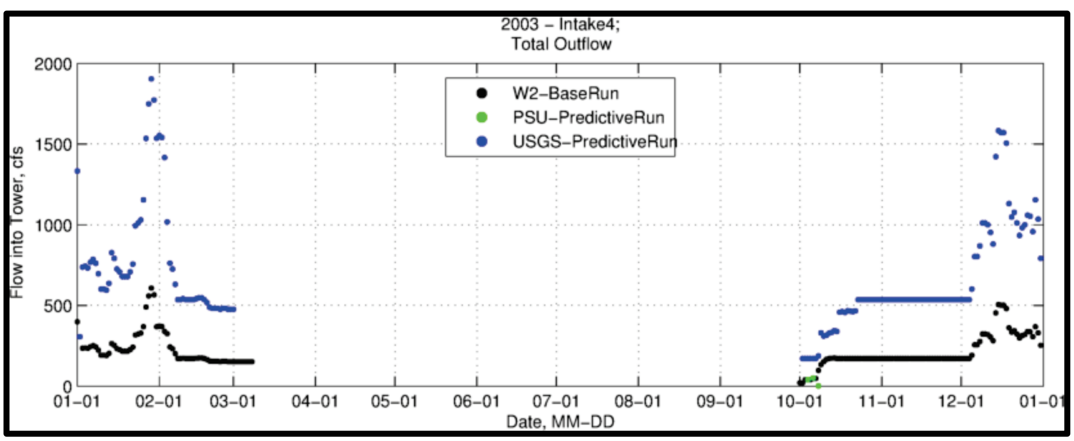


Figure 70. CY03 - Turbidity conduit - flow into tower.

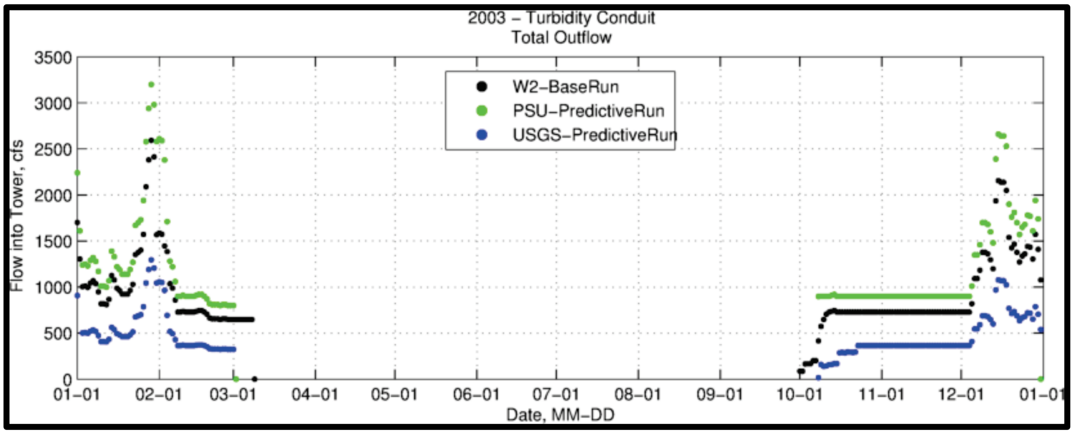


Figure 71. CY10 - LCLPM temperature comparison with target temperatures.

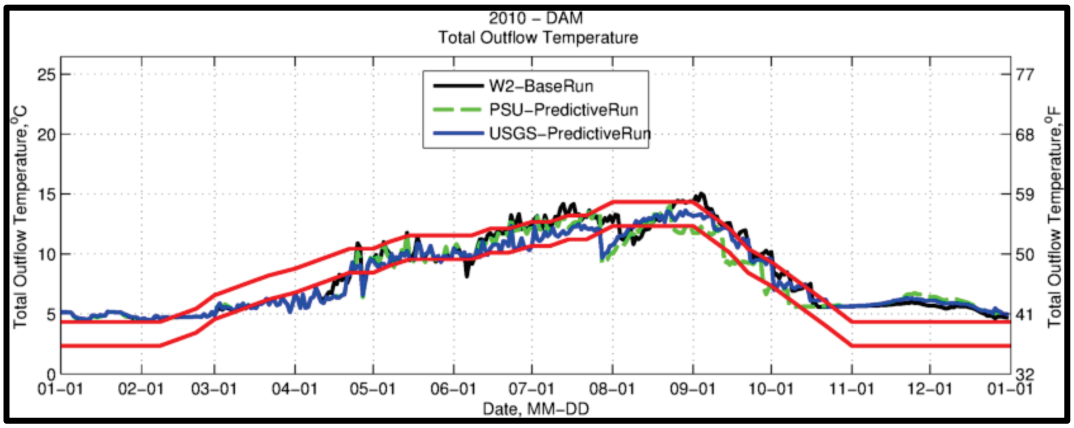


Figure 72. CY10 - Intake 1 - temperature into tower.

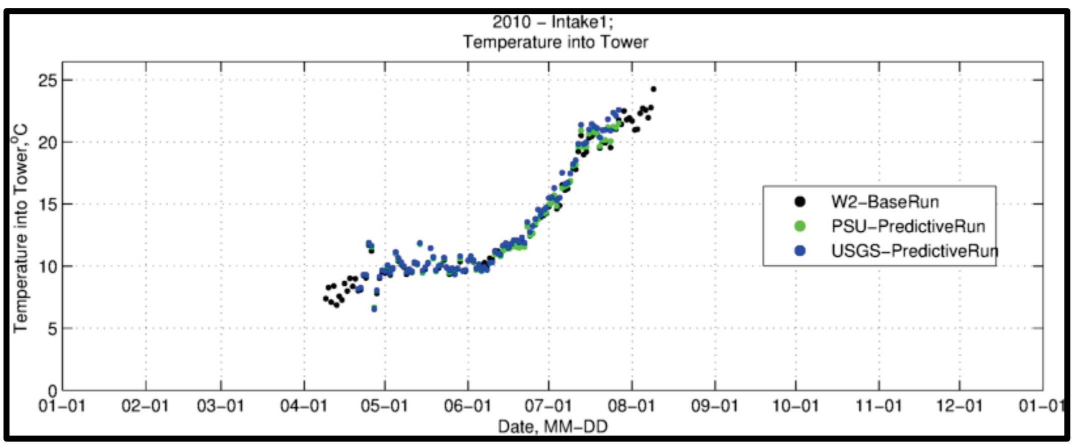


Figure 73. CY10 - Intake 2 - temperature into tower.

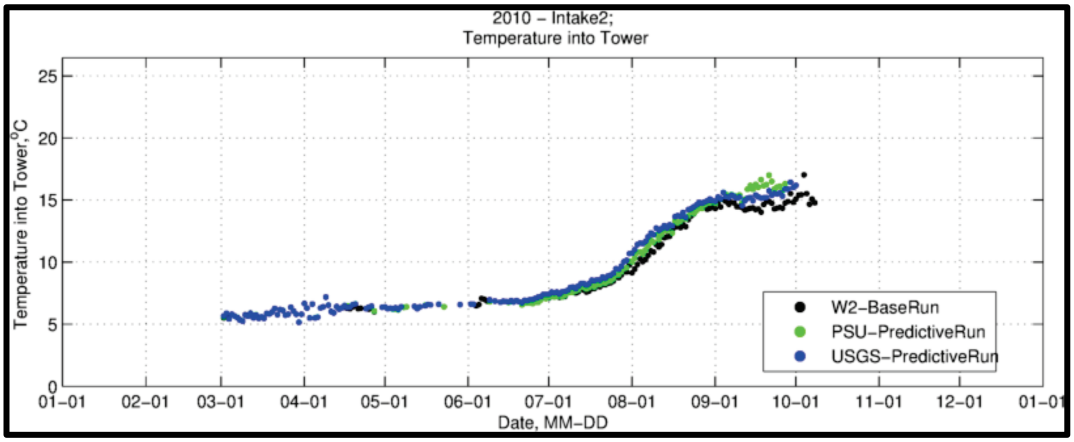


Figure 74. CY10 - Intake 3 - temperature into tower.

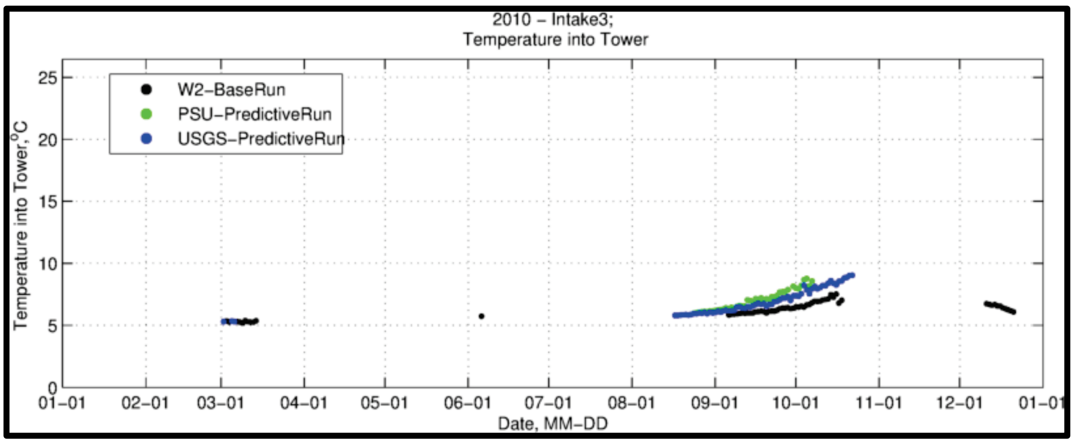


Figure 75. CY10 - Intake 4 - temperature into tower.

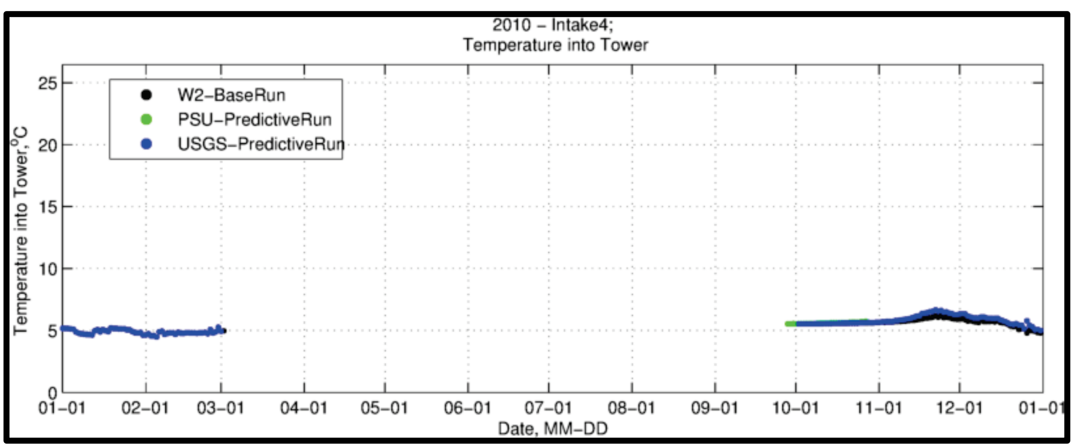


Figure 76. CY10 - Turbidity conduit - temperature into tower.

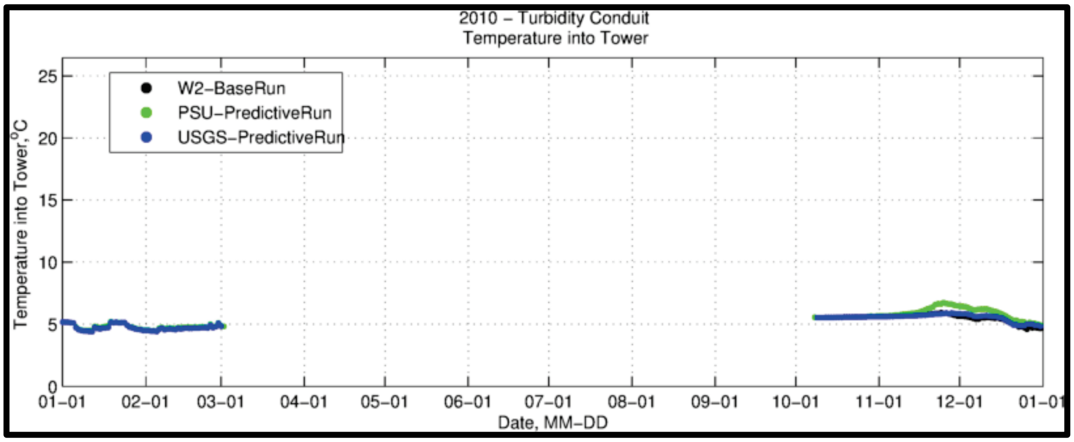


Figure 77. CY10 - Intake 1 - flow into tower.

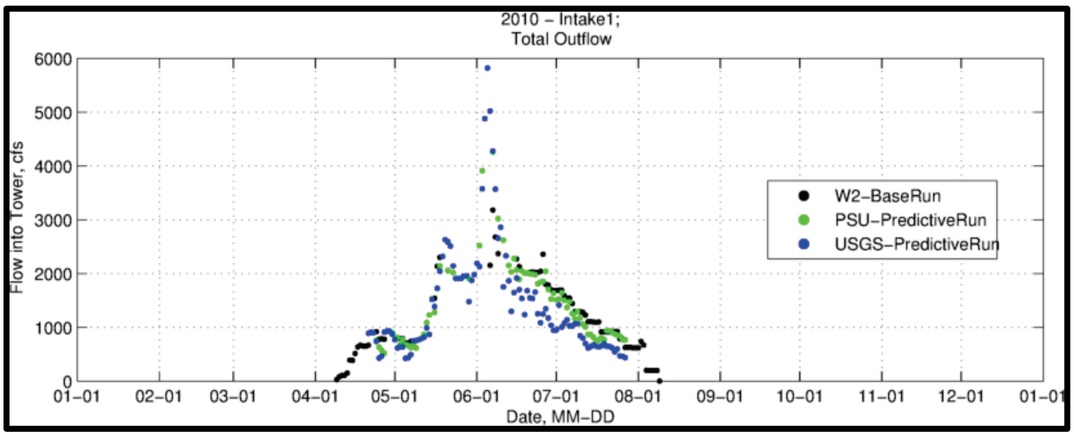


Figure 78. CY10 - Intake 2 - flow into tower.

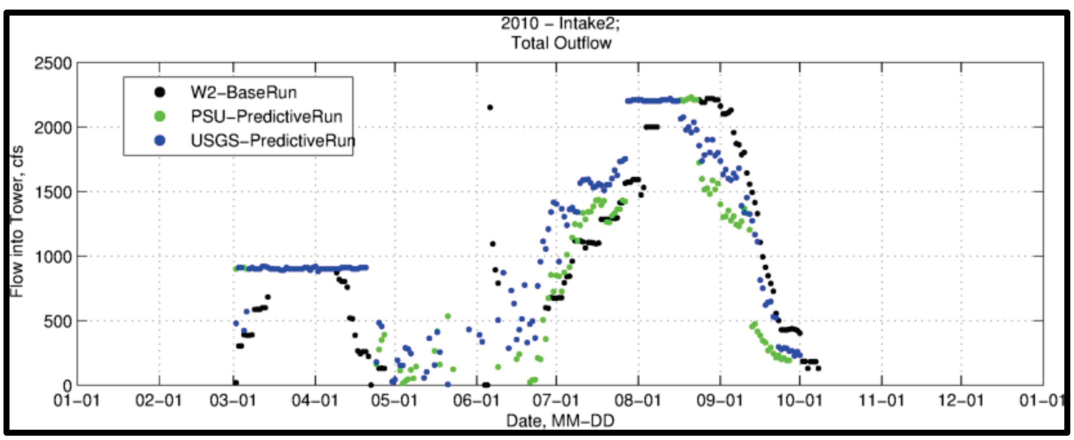


Figure 79. CY10 - Intake 3 - flow into tower.

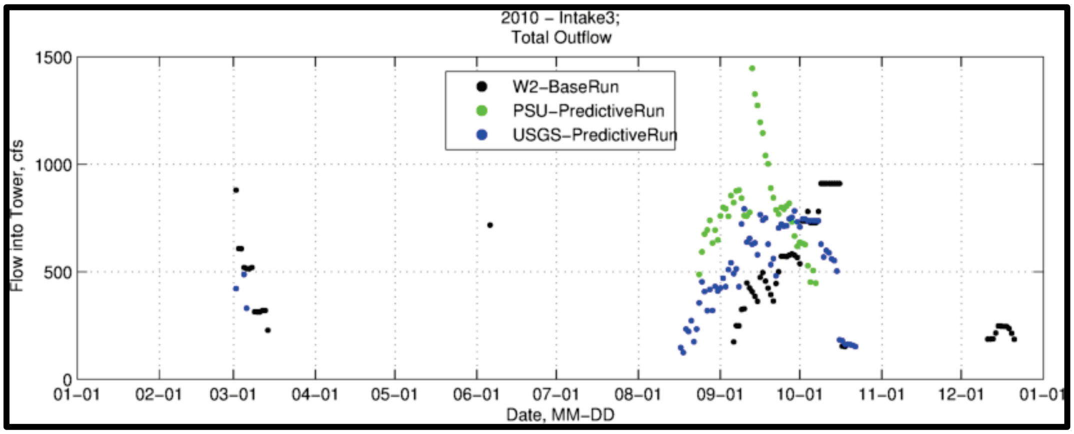


Figure 80. CY10 - Intake 4 - flow into tower.

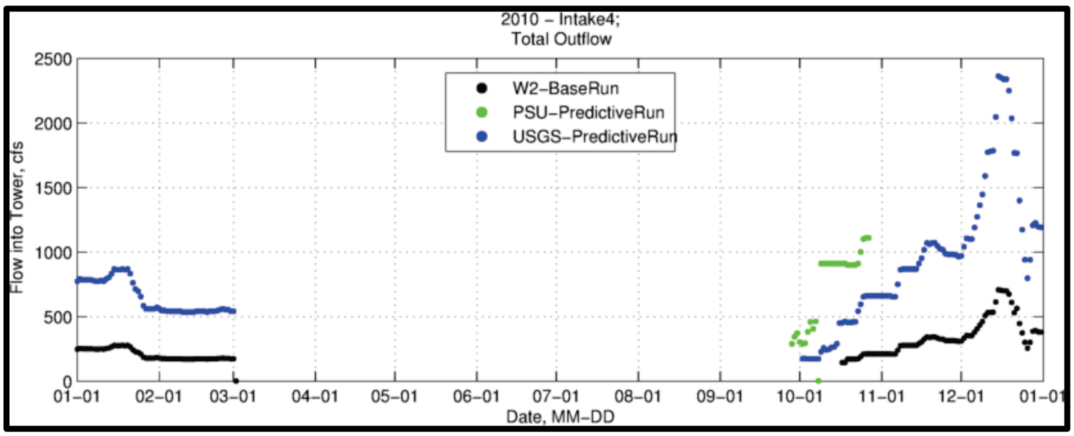


Figure 81. CY10 - Turbidity conduit - flow into tower.

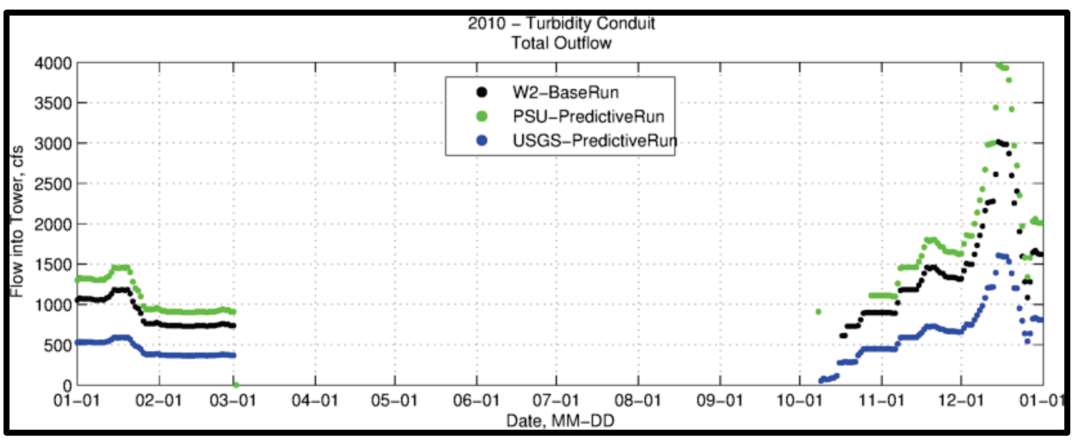
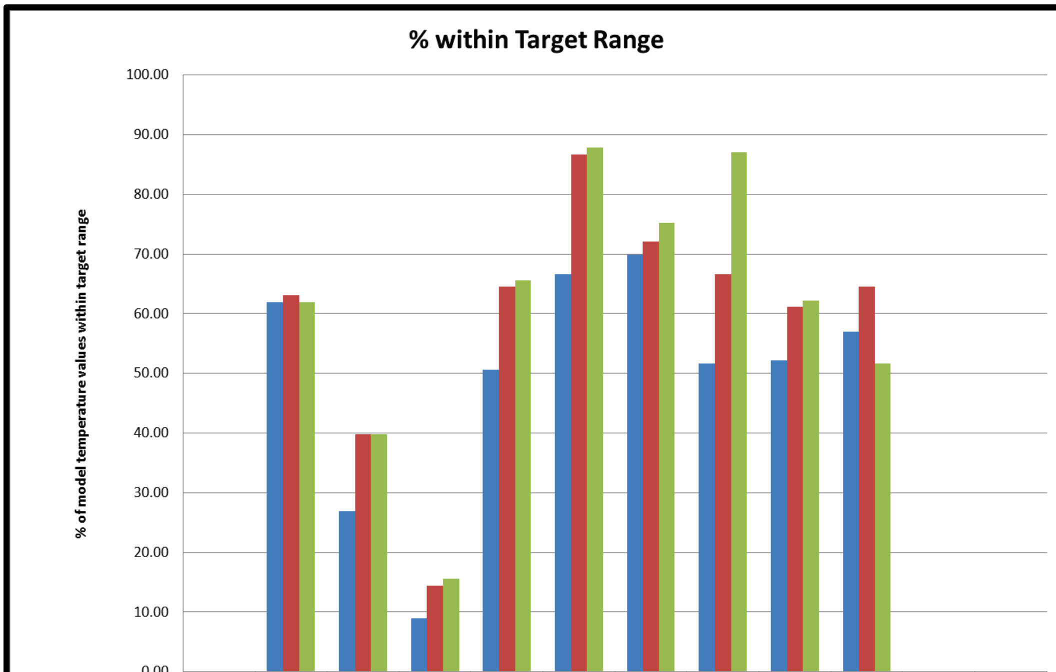


Figure 82. Average % of model temperature within the target range.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
W2-BaseRun	0.00	61.90	26.88	8.89	50.54	66.67	69.89	51.61	52.22	56.99	0.00	0.00
PSU-PredictiveRun	0.00	63.10	39.78	14.44	64.52	86.67	72.04	66.67	61.11	64.52	0.00	0.00
USGS-PredictiveRun	0.00	61.90	39.78	15.56	65.59	87.78	75.27	87.10	62.22	51.61	0.00	0.00

9 Summary and Conclusions

The USACE-ERDC-EL assisted CENWP in updating a W2 model of Lost Creek Lake based on inputs from an existing model of the reservoir. The model was calibrated using data from calendar year (CY) 2001 (dry), 2003 (normal), and 2010 (wet). Across all calendar years, the model captured the quantitative and qualitative trends for temperature and flow. Quantitatively, the model predicted temperatures within 1.0 deg-C for most of the calibration sites (in-lake sites and at the dam), which is far better than many other temperature studies (Arhonditsis and Brett 2004). Qualitatively, trends were consistent with measured data. Model performance statistics were paired temporally and spatially closely with the measured data.

In addition to a fully updated calibrated model, ERDC-EL also developed an application of the model using modified W2 code from the USGS that allows for a better functioning blending algorithm between multiple ports. Using this algorithm has multiple advantages over the current version of W2:

1. One run produces the results needed to obtain the target temperature. With a few minutes spent in updating the w2_selective file, the user can generate the results with far few runs.
2. Multiple outlets can be blended to reach desired temperature. The current version of W2 (PSU) limits the user to at most two ports being blended.

The major downfall of the USGS code is that the base W2 code is not the latest version of the code. The base for the USGS code was the first release of W2v3.7. According to personal correspondence with Dr. Scott Wells (PSU) and Mr. Stewart Rounds, the PSU version of W2 will be updated in a future release to include all of the USGS updates. A secondary downfall of this code is that due to its iterative nature, the run time is also increased (almost tripled in the case of LCLPM).

This model and the corresponding results from the study provide CENWP with a fully capable model in determining how operational changes will impact downstream water temperature. This is extremely important because the Rogue and Applegate temperature Total Maximum Daily Loads (TMDL), Rogue Spring Chinook Conservation Plan, and possibly the Rogue Fall Chinook Conservation Plan require the Corps to review the operations to determine whether improvements to downstream temperature for the benefit of endangered fish can be achieved.

Additional work to consider would be the impacts of these temperatures on fish with respect to egg emergence data. This model, coupled with an in-depth fish analysis, would provide CENWP with invaluable information regarding dam operations and the impacts to fish.

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Appendix A: Bathymetry File

This section contains an image of the bathymetry file used for the LCLM. The only difference between calendar years was the initial water surface elevation used in creating the bathymetry file. W2 V3.7 now has the capability to use a csv file developed in Excel. The images below (Figure A1-Figure A8) are pages from the Excel file used to the develop the csv file; to read them correctly, it is important to know that page two contains the widths for the remaining depths of the reservoir for the first thirteen segments; page four gives the same information for segments 14-28, and so on. Table A1 is the initial water surface (ELWS) used in the development of the bathymetry files for each of the model simulations.

Table A1. Initial ELWS used in bathymetry files for all simulations.

Calendar Year	ELWS (m)	ELWS (ft)
Calibration-2001	552.13	1811.46
Verification-2003	552.37	1812.22
Verification-2010	552.49	1812.64

Figure A1. Page 1 from bathymetry development Excel file.

$ Lost Creek Lake Bathymetry - Updated from 'lcbth.npt' to new csv version - December 17, 2012; updated angles and widths to better fit Google Earth geome

SEG:I	1	2	3	4	5	6	7	8	9	10	11	12	13
DLX	0.000	300.000	300.000	300.000	300.000	300.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000
ELWS	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365
PHIO	0.000	1.920	1.396	0.698	0.175	0.262	0.611	1.309	1.833	2.094	1.222	1.222	1.222
FRICT	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
LAYERH		BR1											
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	67.000	101.600	138.900	176.900	149.100	151.700	193.300	198.900	185.900	229.900	235.300	348.900
1.000	0.000	48.800	89.600	131.100	165.800	139.900	144.900	180.100	188.500	177.500	213.000	223.000	324.200
1.000	0.000	32.800	75.500	125.100	154.100	132.900	140.200	170.700	181.800	171.500	201.000	214.100	307.000
1.000	0.000	23.000	63.200	119.500	146.500	127.800	136.100	165.300	177.200	167.600	194.500	208.200	296.800
1.000	0.000	19.500	57.500	113.900	139.100	123.000	131.700	159.900	172.400	163.200	188.600	202.400	287.100
1.000	0.000	19.100	52.000	108.200	131.700	118.400	127.400	154.500	167.500	159.000	183.000	197.200	278.500
1.000	0.000	0.000	46.400	102.400	124.500	113.700	123.100	149.300	162.700	154.600	177.900	192.400	271.200
1.000	0.000	0.000	40.800	96.500	117.500	109.000	116.800	144.000	157.900	150.200	172.900	187.600	264.100
1.000	0.000	0.000	35.400	90.700	110.400	104.600	114.700	139.000	153.300	146.000	166.200	182.900	257.300
1.000	0.000	0.000	29.400	84.600	103.400	100.300	110.900	134.300	148.800	141.900	163.700	176.300	250.600
1.000	0.000	0.000	24.500	78.700	96.500	96.100	107.300	129.900	144.600	138.000	159.600	174.000	243.900
1.000	0.000	0.000	22.500	72.500	89.600	91.700	103.700	125.800	140.600	134.300	155.700	169.800	237.400
1.000	0.000	0.000	22.000	65.500	82.900	87.400	100.200	121.700	137.000	130.700	152.000	165.900	231.300
1.000	0.000	0.000	0.000	45.500	78.000	84.800	98.800	120.200	136.100	130.000	151.500	165.500	229.800
1.000	0.000	0.000	0.000	34.900	72.600	81.200	96.200	117.300	133.600	127.800	149.500	163.600	227.000
1.000	0.000	0.000	0.000	30.000	66.600	76.700	92.700	113.200	130.100	124.300	145.900	160.100	222.200
1.000	0.000	0.000	0.000	24.100	60.800	72.300	89.100	109.100	126.400	120.800	142.200	156.500	217.600
1.000	0.000	0.000	0.000	18.800	55.100	67.800	85.500	105.000	122.600	117.200	138.500	153.000	213.100
1.000	0.000	0.000	0.000	0.000	49.000	63.100	81.700	100.800	118.800	113.700	134.800	149.400	208.700
1.000	0.000	0.000	0.000	0.000	41.300	57.700	77.800	96.400	115.000	110.100	131.100	145.800	204.300
1.000	0.000	0.000	0.000	0.000	28.400	52.000	73.800	92.100	111.200	106.700	127.500	142.300	200.200
1.000	0.000	0.000	0.000	0.000	16.000	45.800	69.700	87.700	107.400	103.300	123.900	136.900	196.100
1.000	0.000	0.000	0.000	0.000	12.300	39.900	65.500	83.200	103.500	100.000	120.300	135.500	191.900
1.000	0.000	0.000	0.000	0.000	0.000	33.300	61.100	78.700	99.700	96.500	116.800	132.200	187.400
1.000	0.000	0.000	0.000	0.000	0.000	22.000	56.500	74.100	95.700	93.100	113.300	128.800	183.000
1.000	0.000	0.000	0.000	0.000	0.000	15.300	50.200	69.400	91.800	89.600	109.900	125.400	178.900
1.000	0.000	0.000	0.000	0.000	0.000	0.000	36.500	64.600	68.200	86.700	107.300	123.200	176.700
1.000	0.000	0.000	0.000	0.000	0.000	0.000	27.100	57.200	81.300	83.000	103.800	120.200	173.400
1.000	0.000	0.000	0.000	0.000	0.000	0.000	25.325	54.775	78.550	81.700	102.425	118.875	171.850
1.000	0.000	0.000	0.000	0.000	0.000	0.000	23.550	52.350	75.800	80.400	101.050	117.550	170.300
1.000	0.000	0.000	0.000	0.000	0.000	0.000	21.775	49.925	73.050	79.100	95.992	116.225	168.750
1.000	0.000	0.000	0.000	0.000	0.000	0.000	20.000	47.500	70.300	77.800	90.933	114.900	167.200
1.000	0.000	0.000	0.000	0.000	0.000	0.000	16.000	32.600	59.700	72.400	85.875	109.300	160.900
1.000	0.000	0.000	0.000	0.000	0.000	0.000	17.000	27.943	49.000	66.700	80.817	103.300	154.500
1.000	0.000	0.000	0.000	0.000	0.000	0.000	8.000	23.286	30.000	60.200	75.758	97.200	147.700
1.000	0.000	0.000	0.000	0.000	0.000	0.000	5.000	18.629	17.900	51.800	70.700	90.600	140.200
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	13.971	15.343	37.400	65.642	83.900	132.600
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9.314	12.786	37.400	60.583	83.900	132.600
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.000	10.229	37.400	55.525	83.900	132.600
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.671	37.400	50.467	83.900	132.600
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.114	37.400	45.408	83.900	132.600
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.000	37.400	40.350	83.900	132.600
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1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	37.400	30.233	83.900	132.600
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1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure A2. Page 2 from bathymetry development Excel file.

1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.487	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure A3. Page 3 from bathymetry development Excel file.

try (W2-Tools) - September 24, 2013, made corrections for volume-elevation curve November 15, 2013

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000	250.000
552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365
1.222	0.698	0.349	0.349	1.309	1.309	1.309	1.309	1.309	1.134	0.698	0.611	0.698	1.134	1.396
0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
256.200	299.100	353.900	429.800	355.200	331.200	400.600	569.500	508.400	674.500	674.500	744.875	815.250	1025.000	1150.000
242.700	261.800	336.100	410.000	334.100	317.700	381.700	561.600	495.200	666.300	666.300	738.007	809.714	1021.429	1140.000
234.000	270.400	322.800	393.400	318.700	308.300	367.300	552.500	484.600	660.200	660.200	732.414	804.629	1017.857	1130.000
229.800	263.800	313.700	384.100	311.900	302.100	359.700	541.600	477.300	652.800	652.800	725.671	798.543	1014.286	1120.000
225.500	257.100	305.200	375.400	305.300	295.800	353.300	532.400	469.600	643.200	643.200	717.529	791.857	1010.714	1110.000
221.700	250.800	298.400	367.400	299.400	290.100	347.400	524.400	462.500	633.600	633.600	709.511	785.421	1007.143	1100.000
217.000	245.400	292.400	360.700	293.900	284.700	342.100	517.200	455.600	623.800	623.800	701.468	779.136	1003.571	1083.333
212.800	240.200	286.600	354.400	288.600	279.600	336.800	509.900	448.500	613.600	613.600	693.225	772.850	1000.000	1066.667
208.700	235.100	281.100	348.400	283.700	274.700	331.800	502.900	441.600	603.300	603.300	680.850	758.400	980.000	1050.000
205.000	230.200	275.700	342.500	279.000	270.000	326.900	496.000	434.800	593.100	593.100	668.525	743.950	960.000	1033.333
201.500	225.400	270.800	337.000	274.600	265.800	322.200	494.800	428.100	581.600	581.600	655.600	729.600	940.000	1016.667
198.200	220.900	266.200	331.200	273.600	261.700	321.400	484.900	421.900	568.600	568.600	642.025	715.450	920.000	1000.000
197.600	219.100	265.200	329.000	271.600	261.200	319.400	480.400	421.800	554.800	554.800	628.275	701.750	900.000	982.002
196.400	217.400	263.600	326.100	269.400	259.800	317.300	477.600	419.600	469.900	469.900	578.867	687.833	891.667	964.005
192.400	213.100	258.300	319.600	264.000	257.400	314.700	477.500	415.900	421.900	421.900	548.583	675.267	883.333	946.007
192.200	212.300	257.900	317.100	261.900	252.200	308.400	477.400	407.600	412.000	412.000	538.900	665.800	875.000	928.009
189.200	208.700	253.700	310.800	261.300	251.300	305.900	472.400	407.200	403.500	403.500	529.992	656.483	866.667	910.011
186.200	205.200	249.500	304.400	257.700	247.800	305.400	467.500	402.000	396.300	396.300	521.833	647.367	858.333	892.014
183.200	201.700	245.600	298.100	254.100	244.400	305.300	462.600	396.900	390.300	390.300	514.400	638.500	850.000	874.016
180.200	198.200	241.600	291.700	250.400	241.100	303.500	457.500	396.000	384.500	384.500	507.142	629.783	841.667	856.018
177.300	194.800	237.700	285.600	250.100	237.900	302.500	452.800	393.900	379.100	379.100	500.183	621.267	833.333	838.020
174.600	191.500	234.000	279.600	249.300	234.900	301.600	448.400	392.700	373.900	373.900	493.425	612.950	825.000	820.023
171.800	188.300	230.200	273.800	248.600	231.900	295.500	443.900	384.900	368.700	368.700	486.617	604.533	816.667	802.025
169.200	185.100	226.400	268.200	243.600	226.900	294.700	439.500	383.700	363.900	363.900	479.958	596.017	808.333	784.027
166.400	181.800	222.400	262.900	242.900	225.900	293.900	434.600	383.300	359.100	359.100	473.325	587.550	800.000	766.030
163.700	178.500	218.200	257.900	242.200	223.100	292.600	429.500	382.900	354.700	354.700	460.479	566.257	765.714	748.032
162.600	177.000	216.300	255.800	225.500	222.900	278.700	416.200	358.200	354.700	354.700	450.882	547.064	731.429	730.034
160.800	174.400	212.700	252.600	223.900	222.400	277.500	400.500	356.900	353.400	353.400	440.436	527.471	697.143	712.036
159.650	173.050	210.750	250.800	222.775	221.500	276.100	398.300	356.525	351.750	351.750	430.408	509.066	662.857	694.039
158.500	171.700	208.800	249.000	221.650	220.600	274.700	396.100	356.150	350.100	350.100	420.380	490.661	628.571	676.041
157.350	170.350	206.850	247.200	220.525	219.700	273.300	393.900	355.775	348.450	348.450	410.353	472.255	594.286	658.043
156.200	169.000	204.900	245.400	219.400	218.800	271.900	391.700	355.400	346.800	346.800	400.325	453.850	560.000	640.045
151.300	163.500	196.000	238.100	217.900	215.200	270.800	383.500	348.300	340.200	340.200	392.575	444.950	552.100	622.048
146.100	157.900	186.900	231.100	217.000	211.500	270.800	375.700	347.000	333.900	333.900	329.200	436.350	543.500	604.050
140.600	152.000	178.000	224.100	214.500	207.300	270.200	367.600	345.400	327.300	327.300	320.900	427.400	533.900	569.750
134.500	145.600	169.000	216.100	208.900	202.300	264.200	358.400	342.600	319.800	319.800	311.600	416.950	522.300	573.050
128.300	139.000	160.300	208.000	203.200	197.100	263.438	357.238	341.775	318.863	318.863	310.425	415.613	520.800	570.882
128.300	139.000	160.300	208.000	203.200	197.100	262.675	356.075	340.950	317.925	317.925	309.250	414.275	519.300	568.713
128.300	139.000	160.300	208.000	203.200	197.100	261.913	354.913	340.125	316.988	316.988	308.075	412.938	517.800	566.544
128.300	139.000	160.300	208.000	203.200	197.100	261.150	353.750	339.300	316.050	316.050	306.900	411.600	516.300	564.375
128.300	139.000	160.300	208.000	203.200	197.100	260.388	352.588	338.475	315.113	315.113	305.725	410.263	514.800	562.207
128.300	139.000	160.300	208.000	203.200	197.100	259.625	351.425	337.650	314.175	314.175	304.550	408.925	513.300	560.038
128.300	139.000	160.300	208.000	203.200	197.100	258.863	350.263	336.825	313.238	313.238	303.375	407.588	511.800	557.869
128.300	139.000	160.300	208.000	203.200	197.100	258.100	349.100	336.000	312.300	312.300	302.200	406.250	510.300	555.700
122.200	132.200	152.000	200.100	197.600	192.000	252.400	339.500	329.200	304.900	304.900	292.800	395.650	498.500	538.400
115.300	124.400	144.000	192.300	191.900	186.900	251.200	329.800	327.600	300.700	300.700	283.200	389.200	495.200	525.550
110.100	117.400	140.000	189.900	191.500	186.900	246.100	328.700	321.000	299.100	299.100	278.400	381.850	485.300	516.850
103.900	108.500	135.200	187.200	190.400	186.100	245.700	326.400	320.200	293.100	293.100	273.900	378.900	483.900	513.300
94.400	95.800	125.600	179.000	184.000	180.200	241.700	314.400	314.400	288.200	288.200	264.900	371.550	478.200	501.300
75.520	76.640	107.657	156.625	161.000	143.300	195.525	262.700	265.375	260.475	260.475	239.450	343.688	447.925	465.663
56.640	57.480	89.714	134.250	138.000	106.400	175.459	239.430	245.341	244.013	244.727	228.925	315.825	417.650	430.025
37.760	38.320	71.771	111.875	115.000	69.500	155.394	216.160	225.307	227.550	228.979	218.400	306.071	387.375	418.357
18.880	19.160	53.829	89.500	92.000	32.600	135.328	192.890	205.273	211.086	213.230	207.875	296.316	357.100	406.690
0.000	0.000	35.886	67.125	69.000	32.600	115.263	169.620	185.239	194.625	197.482	197.350	286.562	357.100	395.022
0.000	0.000	17.943	44.750	46.000	32.600	95.197	146.350	165.205	178.163	181.734	186.825	276.807	357.100	383.354
0.000	0.000	0.000	22.375	23.000	32.600	75.131	123.080	145.170	161.700	165.986	176.300	267.053	357.100	371.686
0.000	0.000	0.000	0.000	0.000	32.600	55.066	99.810	125.136	145.238	150.238	165.775	257.299	357.100	360.019
0.000	0.000	0.000	0.000	0.000	0.000	35.000	76.540	105.102	128.775	134.489	155.250	243.206	340.039	348.351
0.000	0.000	0.000	0.000	0.000	0.000	0.000	53.770	85.068	112.313	118.741	144.775	229.113	327.978	336.683
0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.000	65.034	95.850	102.993	134.200	215.020	305.917	325.016
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	45.000	79.388	87.245	123.675	200.928	288.856	313.348
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	62.925	71.496	113.150	186.835	271.794	301.680
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	46.462	55.748	102.625	172.742	254.733	290.013
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.000	40.000	92.100	158.649	237.672	278.345
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	81.575	144.557	220.611	266.677
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	71.050	130.464	203.550	255.009

Figure A4. Page 4 from bathymetry development Excel file.

0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	60.525	116.371	186.489	231.119
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	50.000	102.278	169.428	207.230
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	58.186	152.367	183.340
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74.093	135.306	159.450
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	60.000	118.244	135.560
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	101.183	111.670
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	84.122	87.780
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	67.061	63.890
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	50.000	40.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure A5. Page 5 from bathymetry development Excel file.

29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
250.000	250.000	250.000	250.000	250.000	275.000	250.000	250.000	250.000	250.000	225.000	225.000	250.000	200.000	200.000
552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365
1.658	2.007	1.833	1.658	1.309	1.047	0.960	0.698	0.663	0.698	0.733	0.785	0.908	0.960	1.047
0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1219.700	1418.800	1617.900	1617.900	2260.300	2750.100	2780.600	3114.200	3258.100	3402.000	3545.900	2518.500	2930.900	2694.800	2185.000
1195.760	1393.050	1593.300	1593.300	2247.300	2731.800	2772.600	3103.800	3247.333	3390.867	3534.400	2512.200	2886.400	2652.900	2176.800
1171.820	1358.500	1570.700	1570.700	2223.400	2714.500	2767.600	3098.400	3241.767	3385.133	3528.500	2501.800	2836.800	2618.700	2166.000
1147.880	1331.650	1551.100	1551.100	2175.300	2694.500	2751.600	3036.400	3198.700	3361.000	3523.300	2488.400	2785.200	2579.900	2153.200
1123.940	1312.500	1529.800	1529.800	2132.300	2671.900	2739.500	3031.200	3193.233	3355.267	3517.300	2473.300	2736.500	2536.100	2138.400
1100.000	1295.000	1510.700	1510.700	2092.200	2648.100	2726.000	3030.600	3169.400	3308.200	3447.000	2457.200	2688.700	2494.200	2121.500
1090.000	1277.900	1491.900	1491.900	2048.600	2595.100	2711.300	3025.000	3163.733	3302.467	3441.200	2440.900	2642.000	2453.800	2102.600
1080.000	1275.575	1471.900	1471.900	2008.800	2588.800	2695.700	3016.100	3155.667	3295.233	3434.800	2424.700	2595.300	2413.200	2060.500
1070.000	1273.250	1452.200	1452.200	1979.300	2540.600	2679.500	3006.100	3146.100	3286.100	3426.100	2408.700	2550.400	2373.100	2042.300
1060.000	1270.925	1432.500	1432.500	1948.900	2489.700	2663.100	2996.000	3136.333	3276.667	3417.000	2393.100	2507.200	2333.500	2040.600
1050.000	1268.600	1412.700	1412.700	1918.300	2438.000	2646.900	2986.300	3127.033	3267.767	3408.500	2377.700	2465.700	2293.700	2017.800
1040.000	1266.275	1407.900	1407.900	1887.100	2386.900	2594.000	2977.400	3118.700	3260.000	3401.300	2362.500	2426.400	2250.800	1994.100
1030.000	1263.950	1397.900	1397.900	1855.600	2326.300	2575.500	2969.500	3111.667	3253.833	3396.000	2315.300	2421.300	2207.100	1993.300
1020.000	1261.625	1391.300	1391.300	1759.300	2193.700	2468.800	2962.400	3105.767	3249.133	3392.500	2300.700	2408.900	2183.000	1978.200
1010.000	1259.300	1384.000	1384.000	1702.700	2155.700	2340.300	2955.100	3100.200	3245.300	3390.400	2286.200	2388.700	2150.800	1938.700
1000.000	1256.975	1375.600	1375.600	1680.600	2138.100	2276.000	2946.200	3093.767	3241.333	3368.900	2271.800	2365.200	2109.100	1934.700
987.500	1254.650	1366.800	1366.800	1659.300	2123.400	2221.300	2933.400	3084.600	3235.800	3387.000	2257.400	2317.900	2068.300	1905.700
975.000	1252.325	1339.500	1339.500	1638.900	2111.600	2174.000	2914.200	3070.600	3227.000	3383.400	2242.600	2316.200	2028.000	1876.200
962.500	1250.000	1331.100	1331.100	1637.600	2069.400	2167.200	2900.100	3059.267	3218.433	3377.600	2227.600	2292.100	1991.500	1845.200
950.000	1240.000	1322.300	1322.300	1627.200	2058.100	2156.700	2843.200	3018.733	3194.267	3369.800	2212.100	2269.000	1956.300	1812.900
937.500	1230.000	1313.800	1313.800	1620.900	2049.700	2113.500	2780.000	2973.733	3167.467	3361.200	2196.200	2247.600	1924.300	1781.900
925.000	1220.000	1307.100	1307.100	1613.200	2044.200	2103.300	2710.400	2924.667	3138.933	3353.200	2180.000	2227.800	1895.500	1777.100
912.500	1210.000	1302.300	1302.300	1605.000	2041.600	2091.200	2637.800	2873.600	3109.400	3345.200	2163.600	2207.800	1867.700	1775.800
900.000	1200.000	1299.100	1299.100	1572.900	2040.800	2079.300	2563.700	2621.067	3078.433	3335.800	2147.300	2189.000	1839.500	1767.900
887.500	1190.000	1296.100	1296.100	1565.000	2039.800	2075.800	2489.000	2766.900	3044.800	3322.700	2131.100	2169.300	1810.200	1752.600
875.000	1180.000	1290.700	1290.700	1556.700	2034.000	2068.400	2405.400	2705.133	3004.867	3304.600	2115.000	2149.900	1781.000	1725.000
862.500	1170.000	1237.800	1237.800	1487.800	1994.700	1983.300	2109.600	2439.767	2769.933	3100.100	2046.000	2089.000	1768.100	1595.000
850.000	1160.000	1233.100	1233.100	1481.000	1985.700	1980.200	1812.200	2220.833	2629.467	3038.100	1919.100	1981.100	1736.900	1587.600
837.500	1150.000	1232.200	1232.200	1479.650	1984.225	1979.750	1803.875	2213.375	2622.875	3032.375	1906.350	1961.175	1721.750	1579.675
825.000	1140.000	1231.300	1231.300	1478.300	1982.750	1979.300	1795.550	2205.917	2616.283	3026.650	1893.600	1941.250	1706.600	1571.750
812.500	1130.000	1230.400	1230.400	1476.950	1981.275	1978.850	1787.225	2198.458	2609.692	3020.925	1880.850	1921.325	1691.450	1563.825
800.000	1120.000	1229.500	1229.500	1475.600	1979.800	1978.400	1778.900	2191.000	2603.100	3015.200	1868.100	1901.400	1676.300	1555.900
783.425	1110.000	1224.200	1224.200	1468.300	1974.000	1975.300	1765.400	2155.367	2545.333	2935.300	1824.800	1827.500	1612.100	1548.800
766.850	1100.000	1199.700	1199.700	1438.900	1967.100	1970.100	1753.300	2092.133	2430.967	2769.800	1788.500	1773.900	1537.100	1547.500
750.275	1083.333	1194.600	1194.600	1431.900	1959.400	1930.700	1744.200	2032.333	2320.467	2608.600	1751.700	1729.900	1468.000	1547.100
733.700	1066.667	1187.700	1187.700	1423.000	1951.600	1925.700	1738.300	1972.867	2207.433	2442.000	1710.200	1683.800	1396.000	1517.300
717.125	1050.000	1186.825	1186.825	1421.963	1950.663	1924.825	1737.738	1965.913	2194.088	2422.263	1705.175	1678.438	1387.000	1513.650
700.550	1033.333	1185.950	1185.950	1420.925	1949.725	1923.950	1737.175	1958.958	2180.742	2402.525	1700.150	1673.075	1378.000	1510.000
683.975	1016.667	1164.822	1164.512	1396.963	1912.235	1923.075	1736.613	1952.005	2167.396	2382.788	1695.125	1667.713	1369.000	1506.350
667.400	1000.000	1143.693	1143.074	1373.002	1874.745	1922.200	1736.050	1945.050	2154.050	2363.050	1690.100	1662.350	1360.000	1502.700
650.825	975.000	1122.565	1121.636	1349.040	1837.254	1921.325	1735.488	1938.096	2140.705	2343.313	1685.075	1656.988	1351.000	1499.050
634.250	950.000	1101.437	1100.198	1325.079	1799.764	1920.450	1734.925	1931.142	2127.358	2323.575	1680.050	1651.625	1342.000	1495.400
617.675	925.000	1080.309	1078.760	1301.117	1762.274	1919.575	1734.363	1924.188	2114.013	2303.838	1675.025	1646.263	1333.000	1491.750
601.100	900.000	1059.180	1057.322	1277.155	1724.784	1918.700	1733.800	1917.233	2100.667	2284.100	1670.000	1640.900	1324.000	1488.100
578.300	875.000	1038.052	1035.884	1253.194	1687.294	1909.300	1699.100	1858.467	2017.833	2177.200	1631.900	1599.000	1249.000	1462.300
555.900	850.000	1016.974	1014.446	1229.232	1649.804	1898.700	1694.700	1854.400	2014.100	2173.800	1594.100	1555.300	1169.600	1454.000
548.400	825.000	995.796	993.008	1205.271	1612.313	1886.500	1691.700	1849.000	2006.300	2163.600	1487.800	1521.500	1059.400	1442.900
542.700	800.000	974.667	971.570	1181.309	1574.823	1876.600	1688.400	1832.367	1976.333	2120.300	1340.600	1450.700	951.200	1414.000
524.400	738.970	953.539	950.132	1157.347	1537.333	1872.800	1681.400	1824.467	1967.533	2110.600	1268.500	1366.700	891.800	1367.900
483.400	707.905	932.411	928.694	1133.386	1499.843	1781.450	1638.675	1779.700	1920.725	2061.750	1102.675	1190.725	803.575	1179.800
442.400	676.841	911.283	907.256	1109.424	1462.353	1690.100	1595.950	1734.933	1873.917	2012.900	936.850	1014.750	715.350	991.700
401.400	645.777	890.154	885.818	1085.463	1424.863	1598.750	1553.225	1690.167	1827.108	1964.050	771.025	838.775	627.125	803.600
360.400	614.713	869.026	864.380	1061.501	1387.372	1507.400	1510.500	1645.400	1780.300	1915.200	605.200	662.800	538.900	615.500
360.400	604.149	847.898	842.942	1037.539	1349.882	1507.400	1510.500	1645.400	1780.300	1915.200	605.200	662.800	538.900	615.500
360.400	593.585	826.770	821.504	1013.578	1312.392	1507.400	1510.500	1645.400	1780.300	1915.200	605.200	662.800	538.900	615.500
360.400	583.021	805.641	800.066	989.616	1274.902	1507.400	1510.500	1645.400	1780.300	1915.200	605.200	662.800	538.900	615.500
360.400	572.457	784.513	778.628	965.654	1237.412	1507.400	1510.500	1645.400	1780.300	1915.200	605.200	662.800	538.900	615.500
333.600	548.492	763.385	757.190	941.693	1199.921	1427.500	1454.400	1595.233	1736.067	1876.900	579.800	631.600	532.400	593.800
306.700	524.478	742.257	735.752	917.731	1162.431	1378.365	1397.000	1551.800	1700.000	1861.400	577.900	626.800	529.600	589.800
306.700	513.914	721.128	714.314	893.770	1124.941	1329.231	1397.000	1551.800	1612.500	1861.400	577.900	626.800	529.600	589.800
280.000	490.000	700.000	692.876	869.808	1000.000	1280.096	1338.300	1512.233	1525.000	1860.100	575.700	624.900	527.000	588.600
254.000	456.450	658.900	671.438	845.846	960.870	1230.962	1200.000	1470.067	1437.500	1811.000	574.200	624.000	524.400	588.600
254.000	456.450	625.800	638.204	808.554	921.739	1181.827	1156.250	1423.027	1350.000	1811.000	574.200	624.000	524.400	588.600
244.000	434.200	592.700	604.971	771.262	882.609	1132.692	1112.500	1375.988	1262.500	1606.100	562.700	622.000	513.900	588.400
221.700	405.500	559.600	571.737	733.969	843.478	1083.558	1068.750	1328.946	1175.000	1547.900	561.300	619.400	511.500	576.600
221.200	405.500	526.500	538.504	696.677	804.348	1034.423	1025.000	1281.909	1087.500	1547.900	561.300	619.400	511.500	576.600

Figure A6. Page 6 from bathymetry development Excel file.

205.267	373.375	493.400	505.270	659.385	765.217	985.288	981.250	1200.000	1000.000	1493.984	560.500	607.000	509.000	576.500
189.333	341.250	460.300	472.037	622.092	726.087	936.154	937.500	1150.000	965.000	1440.068	545.296	607.000	509.000	576.500
173.400	309.125	427.200	438.803	584.800	686.957	887.019	893.750	1100.000	930.000	1386.152	530.093	604.500	506.500	576.200
157.467	277.000	394.100	405.569	547.508	647.826	837.885	850.000	1050.000	895.000	1332.236	514.869	586.320	491.444	560.327
141.533	244.875	361.000	372.336	510.216	608.696	788.750	806.250	1000.000	860.000	1278.320	499.685	568.140	476.389	544.453
125.600	212.750	327.900	339.102	472.923	569.565	739.615	762.500	950.000	825.000	1224.404	484.461	549.960	461.333	528.580
109.667	180.625	294.800	305.869	435.631	530.435	690.481	718.750	900.000	790.000	1170.488	469.278	531.780	446.278	512.707
93.733	148.500	261.700	272.635	398.339	491.304	641.346	675.000	850.000	755.000	1116.572	454.074	513.600	431.222	496.833
77.800	116.375	228.600	239.401	361.046	452.174	592.212	631.250	800.000	720.000	1062.656	438.870	495.420	416.167	480.960
61.867	84.250	195.500	206.168	323.754	413.043	543.077	587.500	750.000	685.000	1008.740	423.667	477.240	401.111	465.087
45.933	52.125	162.400	172.934	286.462	373.913	493.942	543.750	700.000	650.000	954.824	408.463	459.060	386.056	449.213
30.000	20.000	129.300	139.701	249.169	334.783	444.808	500.000	650.000	606.250	900.908	393.259	440.880	371.000	433.340
0.000	0.000	96.200	106.467	211.677	295.652	395.673	456.250	600.000	562.500	846.992	378.056	422.700	355.944	417.467
0.000	0.000	63.100	73.234	174.585	256.522	346.538	412.500	550.000	518.750	793.076	362.852	404.520	340.889	401.593
0.000	0.000	30.000	40.000	137.292	217.391	297.404	368.750	500.000	475.000	739.160	347.648	386.340	325.833	385.720
0.000	0.000	0.000	0.000	100.000	178.261	248.269	325.000	450.000	431.250	685.244	332.444	368.160	310.778	369.847
0.000	0.000	0.000	0.000	0.000	139.130	199.135	281.250	400.000	387.500	631.328	317.241	349.980	295.722	353.973
0.000	0.000	0.000	0.000	0.000	100.000	150.000	237.500	350.000	343.750	577.412	302.037	331.800	280.667	338.100
0.000	0.000	0.000	0.000	0.000	0.000	0.000	193.750	300.000	300.000	523.496	286.833	313.620	265.611	322.227
0.000	0.000	0.000	0.000	0.000	0.000	0.000	150.000	250.000	256.250	469.580	271.630	295.440	250.556	306.353
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	200.000	212.500	415.664	256.426	277.260	235.500	290.480
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	150.000	168.750	361.748	241.222	259.080	220.444	274.607
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	125.000	307.832	226.019	240.900	205.389	258.733
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	253.916	210.815	222.720	190.333	242.860
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	200.000	195.611	204.540	175.278	226.987
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	180.407	186.360	160.222	211.113
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	165.204	168.180	145.167	195.240
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	150.000	150.000	130.111	179.367
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	115.056	163.493
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	147.620
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	131.747
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	115.873
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure A 7. Page 7 from bathymetry development Excel file.

44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
200.000	200.000	200.000	200.000	0.000	0.000	300.000	300.000	350.000	350.000	350.000	300.000	300.000	300.000	0.000
552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365	552.365
1.100	1.222	1.431	1.676	0.000	0.000	0.765	0.765	5.411	5.498	5.498	0.262	0.349	0.175	0.000
0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1512.900	1100.000	1250.000	1400.000	0.000	0.000	370.900	370.900	345.600	400.000	345.600	734.200	734.200	734.200	0.000
1504.700	990.000	1170.000	1350.000	0.000	0.000	335.500	335.500	334.900	375.000	334.900	711.400	711.400	711.400	0.000
1498.600	936.300	1118.150	1300.000	0.000	0.000	300.900	300.900	324.000	350.000	324.000	691.900	691.900	691.900	0.000
1492.900	930.600	1102.800	1275.000	0.000	0.000	275.300	275.300	312.800	300.000	312.800	674.600	674.600	674.600	0.000
1486.900	924.000	1087.000	1250.000	0.000	0.000	260.900	260.900	301.600	275.000	301.600	656.300	656.300	656.300	0.000
1457.100	917.200	1071.100	1225.000	0.000	0.000	247.400	247.400	291.000	247.400	291.000	639.000	639.000	639.000	0.000
1451.400	898.800	1049.400	1200.000	0.000	0.000	234.900	234.900	280.900	234.900	280.900	622.600	622.600	622.600	0.000
1445.500	892.200	1012.767	1133.333	0.000	0.000	222.900	222.900	271.100	222.900	271.100	606.200	606.200	606.200	0.000
1438.900	885.300	975.983	1066.667	0.000	0.000	211.100	211.100	261.500	211.100	261.500	589.900	589.900	589.900	0.000
1432.200	878.600	939.300	1000.000	0.000	0.000	199.300	199.300	252.200	199.300	252.200	573.500	573.500	573.500	0.000
1425.900	872.400	919.533	966.667	0.000	0.000	186.800	186.800	243.200	186.800	243.200	557.200	557.200	557.200	0.000
1420.400	867.000	900.167	933.333	0.000	0.000	172.800	172.800	234.500	172.800	234.500	540.900	540.900	540.900	0.000
1415.700	862.400	881.200	900.000	0.000	0.000	157.500	157.500	226.200	157.500	226.200	525.100	525.100	525.100	0.000
1412.000	858.800	874.400	890.000	0.000	0.000	131.600	131.600	220.900	131.600	220.900	518.200	518.200	518.200	0.000
1409.000	856.000	868.000	880.000	0.000	0.000	116.800	116.800	214.000	116.800	214.000	508.600	508.600	508.600	0.000
1406.600	853.900	861.950	870.000	0.000	0.000	108.600	108.600	205.800	108.600	205.800	495.000	495.000	495.000	0.000
1404.100	851.900	855.950	860.000	0.000	0.000	100.700	100.700	197.800	100.700	197.800	481.600	481.600	481.600	0.000
1401.100	849.900	849.950	850.000	0.000	0.000	93.000	93.000	189.900	93.000	189.900	468.300	468.300	468.300	0.000
1397.400	847.500	847.917	848.333	0.000	0.000	86.700	86.700	182.300	86.700	182.300	455.100	455.100	455.100	0.000
1393.100	844.700	845.683	846.667	0.000	0.000	80.900	80.900	175.000	80.900	175.000	441.900	441.900	441.900	0.000
1388.800	841.900	843.450	845.000	0.000	0.000	75.200	75.200	167.800	75.200	167.800	429.300	429.300	429.300	0.000
1384.900	839.400	841.367	843.333	0.000	0.000	69.500	69.500	160.800	69.500	160.800	417.000	417.000	417.000	0.000
1381.200	837.100	839.383	841.667	0.000	0.000	63.800	63.800	153.800	63.800	153.800	404.600	404.600	404.600	0.000
1377.200	834.500	837.250	840.000	0.000	0.000	57.500	57.500	146.300	57.500	146.300	391.800	391.800	391.800	0.000
1371.900	831.200	833.782	836.364	0.000	0.000	50.400	50.400	138.200	50.400	138.200	378.400	378.400	378.400	0.000
1364.600	826.700	829.714	832.727	0.000	0.000	42.500	42.500	129.300	42.500	129.300	364.600	364.600	371.600	0.000
1336.100	814.200	821.645	829.091	0.000	0.000	35.000	35.000	116.200	35.000	116.200	349.600	349.600	370.800	0.000
1331.400	813.600	819.527	825.455	0.000	0.000	25.000	25.000	115.000	25.000	115.000	345.000	345.000	369.000	0.000
1330.550	813.575	817.697	821.818	0.000	0.000	18.000	18.000	114.000	18.000	114.000	340.000	340.000	368.000	0.000
1329.700	813.550	815.866	818.182	0.000	0.000	18.000	18.000	113.000	18.000	113.000	338.000	338.000	367.000	0.000
1328.850	813.525	814.035	814.545	0.000	0.000	0.000	0.000	100.400	0.000	100.400	334.400	334.400	366.000	0.000
1326.000	813.500	812.205	810.909	0.000	0.000	0.000	0.000	87.600	0.000	87.600	318.300	318.300	361.000	0.000
1322.700	812.600	809.936	807.273	0.000	0.000	0.000	0.000	76.200	0.000	76.200	302.400	302.400	352.600	0.000
1296.200	810.700	807.168	803.636	0.000	0.000	0.000	0.000	66.600	0.000	66.600	287.600	287.600	343.700	0.000
1291.100	794.400	797.200	800.000	0.000	0.000	0.000	0.000	57.700	0.000	57.700	272.900	272.900	334.100	0.000
1284.200	792.600	795.467	798.333	0.000	0.000	0.000	0.000	48.900	0.000	48.900	257.400	257.400	323.500	0.000
1283.363	792.250	794.458	796.667	0.000	0.000	0.000	0.000	47.763	0.000	47.763	255.063	255.063	322.138	0.000
1282.525	791.900	793.450	795.000	0.000	0.000	0.000	0.000	46.625	0.000	46.625	252.725	252.725	320.775	0.000
1281.688	791.550	792.442	793.333	0.000	0.000	0.000	0.000	45.488	0.000	45.488	250.388	250.388	319.413	0.000
1280.850	791.200	791.433	791.667	0.000	0.000	0.000	0.000	44.350	0.000	44.350	248.050	248.050	318.050	0.000
1280.013	790.850	790.425	790.000	0.000	0.000	0.000	0.000	43.213	0.000	43.213	245.713	245.713	316.688	0.000
1279.175	790.500	789.417	788.333	0.000	0.000	0.000	0.000	42.075	0.000	42.075	243.375	243.375	315.325	0.000
1278.338	790.150	788.408	786.667	0.000	0.000	0.000	0.000	40.938	0.000	40.938	241.038	241.038	313.963	0.000
1277.500	789.800	787.400	785.000	0.000	0.000	0.000	0.000	39.800	0.000	39.800	238.700	238.700	312.600	0.000
1271.500	785.900	784.617	783.333	0.000	0.000	0.000	0.000	29.700	0.000	29.700	220.000	220.000	301.800	0.000
1260.400	781.900	781.783	781.667	0.000	0.000	0.000	0.000	24.400	0.000	24.400	201.400	201.400	290.700	0.000
1251.000	777.900	778.950	780.000	0.000	0.000	0.000	0.000	0.000	0.000	20.000	182.500	182.500	287.400	0.000
1226.000	776.100	770.050	764.000	0.000	0.000	0.000	0.000	0.000	0.000	20.000	167.300	180.750	282.045	0.000
1216.900	775.200	761.600	748.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	154.700	179.000	276.690	0.000
1131.950	750.025	741.013	732.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	116.025	177.250	271.335	0.000
1047.000	724.850	720.425	716.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	88.660	175.500	265.980	0.000
962.050	699.675	699.838	700.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	86.875	173.750	260.624	0.000
877.100	674.500	685.746	696.992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	85.090	170.180	255.269	0.000
877.100	674.500	684.242	693.985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	83.305	166.610	249.914	0.000
877.100	674.500	682.738	690.977	0.000	0.000	0.000	0.000	0.000	0.000	0.000	81.520	163.039	244.559	0.000
877.100	674.500	681.235	687.969	0.000	0.000	0.000	0.000	0.000	0.000	0.000	79.735	159.469	239.204	0.000
877.100	674.500	679.731	684.962	0.000	0.000	0.000	0.000	0.000	0.000	0.000	77.950	155.899	233.849	0.000
826.100	672.800	677.377	681.954	0.000	0.000	0.000	0.000	0.000	0.000	0.000	76.165	152.329	228.494	0.000
777.000	670.700	674.823	678.946	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74.380	148.759	223.139	0.000
777.000	670.700	673.319	675.938	0.000	0.000	0.000	0.000	0.000	0.000	0.000	72.595	145.189	217.784	0.000
729.700	668.300	670.615	672.931	0.000	0.000	0.000	0.000	0.000	0.000	0.000	70.810	141.619	212.429	0.000
714.900	665.700	667.812	669.923	0.000	0.000	0.000	0.000	0.000	0.000	0.000	69.024	138.049	207.073	0.000
714.900	665.700	666.308	666.915	0.000	0.000	0.000	0.000	0.000	0.000	0.000	67.239	134.479	201.718	0.000
712.300	663.200	663.554	663.908	0.000	0.000	0.000	0.000	0.000	0.000	0.000	40.000	103.182	196.363	0.000
709.600	660.900	660.900	660.900	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.000	95.504	191.008	0.000
709.600	660.900	659.723	658.545	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	92.827	185.653	0.000

Figure A8. Page 8 from bathymetry development Excel file.

695.400	658.600	657.395	656.191	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	90.149	180.298	0.000
695.400	658.600	656.218	653.836	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	87.471	174.943	0.000
692.900	645.500	648.491	651.482	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	84.794	169.588	0.000
673.470	629.718	639.423	649.127	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	82.116	164.233	0.000
654.040	613.937	630.355	646.773	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	79.439	158.878	0.000
634.610	598.155	621.287	644.418	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	76.761	153.522	0.000
615.180	582.374	612.219	642.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74.084	148.167	0.000
595.750	566.592	603.151	639.709	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	71.406	142.812	0.000
576.320	550.811	594.083	637.355	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	68.729	137.457	0.000
556.890	535.029	585.015	635.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	66.051	132.102	0.000
537.460	519.248	576.291	633.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	63.373	126.747	0.000
518.030	503.466	567.567	631.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	60.696	121.392	0.000
498.600	487.685	558.842	630.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	58.018	116.037	0.000
479.170	471.903	550.118	628.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	45.000	110.682	0.000
459.740	456.122	541.394	626.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.000	105.327	0.000
440.310	440.340	532.670	625.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.000	99.971	0.000
420.880	424.559	523.946	623.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	94.616	0.000
401.450	408.777	515.222	621.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	89.261	0.000
382.020	392.996	506.498	620.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	83.906	0.000
362.590	377.214	496.940	616.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	78.551	0.000
343.160	361.433	487.383	613.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73.196	0.000
323.730	345.651	477.826	610.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	67.841	0.000
304.300	329.870	468.268	606.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	62.486	0.000
284.870	314.088	458.711	603.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	57.131	0.000
265.440	298.307	449.153	600.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	51.776	0.000
246.010	282.525	420.429	558.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	46.420	0.000
226.580	266.744	391.705	516.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	41.065	0.000
207.150	250.962	362.981	475.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	35.710	0.000
187.720	235.181	334.257	433.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	30.355	0.000
168.290	219.399	305.533	391.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.000	0.000
148.860	203.618	276.809	350.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
129.430	187.836	243.918	300.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110.000	172.055	211.027	250.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	150.000	175.000	200.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	100.000	150.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	100.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix B: W2 Control File with Detailed Modifications

This appendix serves to present the control file (w2_con.npt) used for the calibration of the model (see Figure B1-Figure B11) along with a table of changes for every model run simulated (see Table B1). All other model simulations will be compared to the Calibration w2_selective.npt file. Discussions of all modifications are made in the main report text.

Figure B1. Page 1 from CY01 w2_con.npt file.

```
  W2 Model Version 3.7

TITLE C .............................TITLE..................................
        Version 3.7 Lost Creek Reservior 2001
        Model Run from 01/01/2001 to 12/30/2001 (Jday: 1 to 365)


        CY01-RUN13 - CY01-RUN12
                   - Adjust timing on WSC increase in WSC file.
                   - Based on Run12 Results.
                   -

        Tammy Threadgill - USACE ERDC EL
        ........................................................................
GRID         NWB     NBR     IMX     KMX   NPROC  CLOSEC
               1       2      58     104       1     OFF

IN/OUTFL     NTR     NST     NIW     NWD     NGT     NSP     NPI     NPU
               0       5       0       0       0       0       0       0

CONSTITU     NGC     NSS     NAL     NEP    NBOD     NMC     NZP
               0       0       0       0       0       0       0

MISCELL     NDAY SELECTC HABTATC ENVIRPC AERATEC INITUWL
             100     OFF     OFF     OFF     OFF     OFF

TIME CON  TMSTRT   TMEND    YEAR
          1.0000 365.000    2001

DLT CON      NDT  DLTMIN DLTINTR
               1 0.10000     OFF

DLT DATE    DLTD    DLTD    DLTD    DLTD    DLTD    DLTD    DLTD    DLTD    DLTD
         1.00000

DLT MAX   DLTMAX  DLTMAX  DLTMAX  DLTMAX  DLTMAX  DLTMAX  DLTMAX  DLTMAX  DLTMAX
         3600.00

DLT FRN     DLTF    DLTF    DLTF    DLTF    DLTF    DLTF    DLTF    DLTF    DLTF
            0.90

DLT LIMI    VISC    CELC
WB 1          ON      ON

BRANCH G      US      DS     UHS     DHS     UQB     DQB   NLMIN   SLOPE  SLOPEC
BR1            2      47       0       0       0       0       1 0.00000 0.00000
BR2           50      57       0      36       0       0       1 0.00000 0.00000

LOCATION     LAT    LONG    EBOT      BS      BE    JBDN
WB 1     42.6900 122.658 472.440       1       2       1

INIT CND     T2I    ICEI  WTYPEC   GRIDC
WB 1       5.444   0.000   FRESH    RECT

CALCULAT     VBC     EBC     MBC     PQC     EVC     PRC
WB 1         OFF     OFF     OFF      ON      ON     OFF

DEAD SEA   WINDC    QINC   QOUTC   HEATC
WB 1          ON      ON      ON      ON

INTERPOL   QINIC   DTRIC    HDIC
BR1          OFF     OFF     OFF
BR2          OFF     OFF     OFF

HEAT EXCH  SLHTC    SROC  RHEVAP   METIC  FETCHC     AFW     BFW     CFW   WINDH
WB 1        TERM     OFF     OFF      ON     OFF 9.20000 0.46000 2.00000 10.0000

ICE COVE    ICEC  SLICEC  ALBEDO   HWICE    BICE    GICE  ICEMIN   ICET2
WB 1         OFF  DETAIL 0.25000 10.0000 0.60000 0.07000 0.05000 3.00000

TRANSPOR   SLTRC   THETA
WB 1    ULTIMATE    0.55

HYD COEF      AX      DX    CBHE    TSED      FI   TSEDF   FRICC      Z0
WB 1     1.00000 1.00000 0.30000  11.984 0.01000 1.00000    MANN 0.00100

EDDY VISC    AZC   AZSLC   AZMAX     FBC       E   ARODI STRCKLR BOUNDFR  TKECAL
WB 1          W2     IMP     1.0

N STRUC     NSTR
BR1            5
BR2            0

STR INT    STRIC   STRIC   STRIC   STRIC   STRIC   STRIC   STRIC   STRIC   STRIC
BR 1          ON      ON      ON      ON      ON
BR 2

STR TOP    KTSTR   KTSTR   KTSTR   KTSTR   KTSTR   KTSTR   KTSTR   KTSTR   KTSTR
BR1            2       2       2       2       2
BR2

STR BOT    KBSTR   KBSTR   KBSTR   KBSTR   KBSTR   KBSTR   KBSTR   KBSTR   KBSTR
BR 1         100     100     100     100     100
```

Figure B2. Page 2 from CY01 w2_con.npt file.

```
BR2

STR SINK   SINKC   SINKC   SINKC   SINKC   SINKC   SINKC   SINKC   SINKC   SINKC
BR1        POINT   POINT   POINT   POINT   POINT
BR2

STR ELEV    ESTR    ESTR    ESTR    ESTR    ESTR    ESTR    ESTR    ESTR    ESTR
BR1      564.642 547.878 529.590 502.158 488.442
BR2

STR WIDT    WSTR    WSTR    WSTR    WSTR    WSTR    WSTR    WSTR    WSTR    WSTR
BR1
BR2

PIPES       IUPI    IDPI    EUPI    EDPI     WPI   DLXPI     FPI  FMINPI  LATPIC DY

PIPE UP    PUPIC   ETUPI   EBUPI   KTUPI   KBUPI

PIPE DOWN  PDPIC   ETDPI   EBDPI   KTDPI   KBDPI

SPILLWAY    IUSP    IDSP     ESP    A1SP    B1SP    A2SP    B2SP   WTHLC

SPILL UP   PUSPC   ETUSP   EBUSP   KTUSP   KBUSP

SPILL DOWN PDSPC   ETUSP   EBUSP   KTDSP   KBDSP

SPILL GAS GASSPC    EQSP  AGASSP  BGASSP  CGASSP

GATES       IUGT    IDGT     EGT    A1GT    B1GT    G1GT    A2GT    B2GT    G2GT

GATE WEIR   GTA1    GTB1    GTA2    GTB2  DYNVAR    GTIC

GATE UP    PUGTC   ETUGT   EBUGT   KTUGT   KBUGT

GATE DOWN  PDGTC   ETDGT   EBDGT   KTDGT   KBDGT

GATE GAS  GASGTC    EQGT  AGASGT  BGASGT  CGASGT

PUMPS 1     IUPU    IDPU     EPU  STRTPU   ENDPU   EONPU  EOFFPU     QPU   WTHLC DY

PUMPS 2     PPUC    ETPU    EBPU    KTPU    KBPU

WEIR SEG     IWR     IWR     IWR     IWR     IWR     IWR     IWR     IWR     IWR

WEIR TOP    KTWR    KTWR    KTWR    KTWR    KTWR    KTWR    KTWR    KTWR    KTWR

WEIR BOT    KBWR    KBWR    KBWR    KBWR    KBWR    KBWR    KBWR    KBWR    KBWR

WD INT      WDIC    WDIC    WDIC    WDIC    WDIC    WDIC    WDIC    WDIC    WDIC

WD SEG       IWD     IWD     IWD     IWD     IWD     IWD     IWD     IWD     IWD

WD ELEV      EWD     EWD     EWD     EWD     EWD     EWD     EWD     EWD     EWD

WD TOP      KTWD    KTWD    KTWD    KTWD    KTWD    KTWD    KTWD    KTWD    KTWD

WD BOT      KBWD    KBWD    KBWD    KBWD    KBWD    KBWD    KBWD    KBWD    KBWD

TRIB PLA    PTRC    PTRC    PTRC    PTRC    PTRC    PTRC    PTRC    PTRC    PTRC

TRIB INT    TRIC    TRIC    TRIC    TRIC    TRIC    TRIC    TRIC    TRIC    TRIC

TRIB SEG     ITR     ITR     ITR     ITR     ITR     ITR     ITR     ITR     ITR

TRIB TOP  ELTRT   ELTRT   ELTRT   ELTRT   ELTRT   ELTRT   ELTRT   ELTRT   ELTRT

TRIB BOT  ELTRB   ELTRB   ELTRB   ELTRB   ELTRB   ELTRB   ELTRB   ELTRB   ELTRB
```

Figure B3. Page 3 from CY01 w2_con.npt file.

```
DST TRIB     DTRC     DTRC     DTRC     DTRC     DTRC     DTRC     DTRC     DTRC     DTRC
BR 1           ON
BR 2          OFF

HYD PRIN   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC   HPRWBC
NVIOL         OFF
U              ON
W              ON
T              ON
RHO           OFF
AZ            OFF
SHEAR         OFF
ST            OFF
SB            OFF
ADMX          OFF
DM            OFF
HDG           OFF
ADMZ          OFF
HPG           OFF
GRAV          OFF

SNP PRINT    SNPC     NSNP    NISNP
WB 1           ON        1        4

SNP DATE     SNPD     SNPD     SNPD     SNPD     SNPD     SNPD     SNPD     SNPD     SNPD
WB 1      1.00000

SNP FREQ     SNPF     SNPF     SNPF     SNPF     SNPF     SNPF     SNPF     SNPF     SNPF
WB 1      1.00000

SNP SEG      ISNP     ISNP     ISNP     ISNP     ISNP     ISNP     ISNP     ISNP     ISNP
WB 1            2       18       34       47

SCR PRINT    SCRC     NSCR
WB 1           ON        1

SCR DATE     SCRD     SCRD     SCRD     SCRD     SCRD     SCRD     SCRD     SCRD     SCRD
WB 1      1.00000

SCR FREQ     SCRF     SCRF     SCRF     SCRF     SCRF     SCRF     SCRF     SCRF     SCRF
WB 1      0.10000

PRF PLOT     PRFC     NPRF    NIPRF
WB 1          OFF

PRF DATE     PRFD     PRFD     PRFD     PRFD     PRFD     PRFD     PRFD     PRFD     PRFD


PRF FREQ     PRFF     PRFF     PRFF     PRFF     PRFF     PRFF     PRFF     PRFF     PRFF


PRF SEG      IPRF     IPRF     IPRF     IPRF     IPRF     IPRF     IPRF     IPRF     IPRF


SPR PLOT     SPRC     NSPR    NISPR
WB 1           ON        1       46

SPR DATE     SPRD     SPRD     SPRD     SPRD     SPRD     SPRD     SPRD     SPRD     SPRD
WB 1         1.00

SPR FREQ     SPRF     SPRF     SPRF     SPRF     SPRF     SPRF     SPRF     SPRF     SPRF
WB 1         1.00

SPR SEG      ISPR     ISPR     ISPR     ISPR     ISPR     ISPR     ISPR     ISPR     ISPR
WB 1            2        3        4        5        6        7        8        9       10
               11       12       13       14       15       16       17       18       19
               20       21       22       23       24       25       26       27       28
               29       30       31       32       33       34       35       36       37
               38       39       40       41       42       43       44       45       46
               47

VPL PLOT     VPLC     NVPL
WB 1           ON        1

VPL DATE     VPLD     VPLD     VPLD     VPLD     VPLD     VPLD     VPLD     VPLD     VPLD
WB 1          1.0

VPL FREQ     VPLF     VPLF     VPLF     VPLF     VPLF     VPLF     VPLF     VPLF     VPLF
WB 1        500.0

CPL PLOT     CPLC     NCPL  TECPLOT
WB 1          OFF        2       ON

CPL DATE     CPLD     CPLD     CPLD     CPLD     CPLD     CPLD     CPLD     CPLD     CPLD


CPL FREQ     CPLF     CPLF     CPLF     CPLF     CPLF     CPLF     CPLF     CPLF     CPLF


FLUXES       FLXC     NFLX
WB 1          OFF        0
```

Figure B4. Page 4 from CY01 w2_con.npt file.

```
FLX DATE     FLXD    FLXD    FLXD    FLXD    FLXD    FLXD    FLXD    FLXD    FLXD
WB 1

FLX FREQ     FLXF    FLXF    FLXF    FLXF    FLXF    FLXF    FLXF    FLXF    FLXF
WB 1

TSR PLOT     TSRC    NTSR   NITSR
               ON       1       4

TSR DATE     TSRD    TSRD    TSRD    TSRD    TSRD    TSRD    TSRD    TSRD    TSRD
             1.00

TSR FREQ     TSRF    TSRF    TSRF    TSRF    TSRF    TSRF    TSRF    TSRF    TSRF
              1.0

TSR SEG      ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR
WB 1            2      18      34      47

TSR LAYE     ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR
             0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00

WITH OUT     WDOC    NWDO   NIWDO
               ON       1       1

WITH DAT     WDOD    WDOD    WDOD    WDOD    WDOD    WDOD    WDOD    WDOD    WDOD
             1.00

WITH FRE     WDOF    WDOF    WDOF    WDOF    WDOF    WDOF    WDOF    WDOF    WDOF
             1.00

WITH SEG     IWDO    IWDO    IWDO    IWDO    IWDO    IWDO    IWDO    IWDO    IWDO
               47

RESTART      RSOC    NRSO    RSIC
              OFF       0     OFF

RSO DATE     RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD


RSO FREQ     RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF


CST COMP      CCC    LIMC     CUF
              OFF     OFF      10

CST ACTIVE    CAC
TDS           OFF
PO4           OFF
NH4           OFF
NO3           OFF
DSI           OFF
PSI           OFF
FE            OFF
LDOM          OFF
RDOM          OFF
LPOM          OFF
RPOM          OFF
DO            OFF
TIC           OFF
ALK           OFF
LDOM-P        OFF
RDOM-P        OFF
LPOM-P        OFF
RPOM-P        OFF
LDOM-N        OFF
RDOM-N        OFF
LPOM-N        OFF
RPOM-N        OFF

CST DERI    CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC
DOC           OFF
POC           OFF
TOC           OFF
DON           OFF
PON           OFF
TON           OFF
TKN           OFF
TN            OFF
DOP           OFF
POP           OFF
TOP           OFF
TP            OFF
APR           OFF
CHLA          OFF
ATOT          OFF
%DO           OFF
TSS           OFF
TISS          OFF
CBOD          OFF
pH            OFF
CO2           OFF
HCO3          OFF
```

Figure B5. Page 5 from CY01 w2_con.npt file.

```
CO3           OFF

CST FLUX    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC
TISSIN        OFF
TISSOUT       OFF
PO4AR         OFF
PO4AG         OFF
PO4AP         OFF
PO4ER         OFF
PO4EG         OFF
PO4EP         OFF
PO4POM        OFF
PO4DOM        OFF
PO4OM         OFF
PO4SED        OFF
PO4SOD        OFF
PO4SET        OFF
NH4NITR       OFF
NH4AR         OFF
NH4AG         OFF
NH4AP         OFF
NH4ER         OFF
NH4EG         OFF
NH4EP         OFF
NH4POM        OFF
NH4DOM        OFF
NH4OM         OFF
NH4SED        OFF
NH4SOD        OFF
NO3DEN        OFF
NO3AG         OFF
NO3EG         OFF
NO3SED        OFF
DSIAG         OFF
DSIEG         OFF
DSIPIS        OFF
DSISED        OFF
DSISOD        OFF
DSISET        OFF
PSIAM         OFF
PSINET        OFF
PSIDK         OFF
FESET         OFF
FESED         OFF
LDOMDK        OFF
LRDOM         OFF
RDOMDK        OFF
LDOMAP        OFF
LDOMEP        OFF
LPOMDK        OFF
LRPOM         OFF
RPOMDK        OFF
LPOMAP        OFF
LPOMEP        OFF
LPOMSET       OFF
RPOMSET       OFF
CBODDK        OFF
DOAP          OFF
DOAR          OFF
DOEP          OFF
DOER          OFF
DOPOM         OFF
DODOM         OFF
DOOM          OFF
DONITR        OFF
DOCBOD        OFF
DOREAR        OFF
DOSED         OFF
DOSOD         OFF
TICAG         OFF
TICEG         OFF
SEDDK         OFF
SEDAS         OFF
SEDLPOM       OFF
SEDSET        OFF
SODDK         OFF

CST ICON    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB
TDS        0.00000
PO4        0.00200
NH4        0.00500
NO3        0.04000
DSI        0.00000
PSI        0.00000
FE         0.00000
LDOM       0.10000
RDOM       0.10000
LPOM       0.10000
RPOM       0.10000
DO         12.0000
TIC        5.00000
ALK        19.8000
LDOM-P     0.00050
```

Figure B6. Page 6 from CY01 w2_con.npt file.

```
RDOM-P   0.00050
LPOM-P   0.00050
RPOM-P   0.00050
LDOM-N   0.00800
RDOM-N   0.00800
LPOM-N   0.00800
RPOM-N   0.00800

CST PRIN  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC
TDS          OFF
PO4          OFF
NH4          OFF
NO3          OFF
DSI          OFF
PSI          OFF
FE           OFF
LDOM         OFF
RDOM         OFF
LPOM         OFF
RPOM         OFF
DO           OFF
TIC          OFF
ALK          OFF
LDOM-P       OFF
RDOM-P       OFF
LPOM-P       OFF
RPOM-P       OFF
LDOM-N       OFF
RDOM-N       OFF
LPOM-N       OFF
RPOM-N       OFF

CIN CON   CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC
TDS          OFF     OFF
PO4          OFF     OFF
NH4          OFF     OFF
NO3          OFF     OFF
DSI          OFF     OFF
PSI          OFF     OFF
FE           OFF     OFF
LDOM         OFF     OFF
RDOM         OFF     OFF
LPOM         OFF     OFF
RPOM         OFF     OFF
DO           OFF     OFF
TIC          OFF     OFF
ALK          OFF     OFF
LDOM-P       OFF     OFF
RDOM-P       OFF     OFF
LPOM-P       OFF     OFF
RPOM-P       OFF     OFF
LDOM-N       OFF     OFF
RDOM-N       OFF     OFF
LPOM-N       OFF     OFF
RPOM-N       OFF     OFF

CTR CON   CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC
TDS
PO4
NH4
NO3
DSI
PSI
FE
LDOM
RDOM
LPOM
RPOM
DO
TIC
ALK
LDOM-P
RDOM-P
LPOM-P
RPOM-P
LDOM-N
RDOM-N
LPOM-N
RPOM-N

CDT CON   CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC
TDS          OFF     OFF
PO4          OFF     OFF
NH4          OFF     OFF
NO3          OFF     OFF
DSI          OFF     OFF
PSI          OFF     OFF
FE           OFF     OFF
LDOM         OFF     OFF
RDOM         OFF     OFF
LPOM         OFF     OFF
RPOM         OFF     OFF
DO           OFF     OFF
```

Figure B7. Page 7 from CY01 w2_con.npt file.

```
TIC          OFF      OFF
ALK          OFF      OFF
LDOM-P       OFF      OFF
RDOM-P       OFF      OFF
LPOM-P       OFF      OFF
RPOM-P       OFF      OFF
LDOM-N       OFF      OFF
RDOM-N       OFF      OFF
LPOM-N       OFF      OFF
RPOM-N       OFF      OFF

CPR CON    CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC
TDS          OFF      OFF
PO4          OFF      OFF
NH4          OFF      OFF
NO3          OFF      OFF
DSI          OFF      OFF
PSI          OFF      OFF
FE           OFF      OFF
LDOM         OFF      OFF
RDOM         OFF      OFF
LPOM         OFF      OFF
RPOM         OFF      OFF
DO           OFF      OFF
TIC          OFF      OFF
ALK          OFF      OFF
LDOM-P       OFF      OFF
RDOM-P       OFF      OFF
LPOM-P       OFF      OFF
RPOM-P       OFF      OFF
LDOM-N       OFF      OFF
RDOM-N       OFF      OFF
LPOM-N       OFF      OFF
RPOM-N       OFF      OFF

EX COEF     EXH2O     EXSS     EXOM     BETA      EXC     EXIC
WB 1        0.550   0.1000  0.10000     0.55      OFF      OFF

ALG EX        EXA      EXA      EXA      EXA      EXA      EXA

ZOO EX        EXZ      EXZ      EXZ      EXZ      EXZ      EXZ

MACRO EX      EXM      EXM      EXM      EXM      EXM      EXM

GENERIC     CGQ10    CG0DK    CG1DK      CGS

S SOLIDS      SSS    SEDRC    TAUCR

ALGAL RATE     AG       AR       AE       AM       AS     AHSP     AHSN    AHSSI     ASAT

ALGAL TEMP    AT1      AT2      AT3      AT4      AK1      AK2      AK3      AK4

ALG STOI     ALGP     ALGN     ALGC    ALGSI    ACHLA    ALPOM    ANEQN     ANPR

EPIPHYTE     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC
EPI1          OFF

EPI PRIN     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC
EPI1          OFF

EPI INIT    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI

EPI RATE       EG       ER       EE       EM       EB     EHSP     EHSN    EHSSI

EPI HALF     ESAT      EHS    ENEQN     ENPR

EPI TEMP      ET1      ET2      ET3      ET4      EK1      EK2      EK3      EK4

EPI STOI       EP       EN       EC      ESI    ECHLA     EPOM

ZOOP RATE      ZG       ZR       ZM     ZEFF    PREFP   ZOOMIN     ZS2P

ZOOP ALGP   PREFA    PREFA    PREFA    PREFA    PREFA    PREFA    PREFA    PREFA    PREFA

ZOOP ZOOP   PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ

ZOOP TEMP     ZT1      ZT2      ZT3      ZT4      ZK1      ZK2      ZK3      ZK4
```

Figure B8. Page 8 from CY01 w2_con.npt file.

```
ZOOP STOI      ZP       ZN       ZC

MACROPHYT MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC  MACWBC
Mac1         OFF

MAC PRINT MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC  MPRWBC
Mac1         OFF

MAC INI  MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI

MAC RATE       MG       MR       MM     MSAT     MHSP     MHSN     MHSC     MPOM  LRPMAC

MAC SED      PSED     NSED

MAC DIST     MBMP     MMAX

MAC DRAG   CDDRAG      DWV     DWSA    ANORM

MAC TEMP      MT1      MT2      MT3      MT4      MK1      MK2      MK3      MK4

MAC STOICH     MP       MN       MC

DOM        LDOMDK   RDOMDK    LRDDK

POM        LPOMDK   RPOMDK    LRPDK     POMS

OM STOIC     ORGP     ORGN     ORGC    ORGSI

OM RATE      OMT1     OMT2     OMK1     OMK2

CBOD         KBOD     TBOD     RBOD    CBODS

CBOD STOIC   BODP     BODN     BODC     BODC

PHOSPHOR     PO4R    PARTP

AMMONIUM     NH4R    NH4DK

NH4 RATE    NH4T1    NH4T2    NH4K1    NH4K2

NITRATE    NO3DK      NO3S FNO3SED

NO3 RATE    NO3T1    NO3T2    NO3K1    NO3K2

SILICA       DSIR     PSIS    PSIDK   PARTSI

IRON          FER      FES

SED CO2      CO2R

STOICH 1    O2NH4     O2OM

STOICH 2     O2AR     O2AG

STOICH 3     O2ER     O2EG

STOICH 4     O2ZR

STOICH 5     O2MR     O2MG

O2 LIMIT    O2LIM

SEDIMENT     SEDC   SEDPRC    SEDCI     SEDK     SEDS     FSOD     FSED     SEDB DYNSEDK
```

Figure B9. Page 9 from CY01 w2_con.npt file.

```
WB 1          OFF      OFF 0.00000 0.10000      0.1 1.00000 1.00000      0.0      OFF

SOD RATE   SODT1   SODT2   SODK1   SODK2
WB 1     4.00000 30.0000 0.10000 0.99000

S DEMAND      SOD      SOD      SOD      SOD      SOD      SOD      SOD      SOD      SOD
         0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
         0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
         0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
         0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
         0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
         0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000 0.10000
         0.10000 0.10000 0.10000 0.10000

REAERATION  TYPE    EQN#   COEF1   COEF2   COEF3   COEF4
WB 1        LAKE       6 0.00000 0.00000 0.00000 0.00000

RSI FILE.................................RSIFN................................
        rsi.npt

QWD FILE.................................QWDFN................................
        qwd.npt

QGT FILE.................................QGTFN................................
        qgt.npt

WSC FILE.................................WSCFN................................
        LCL-WSC-012314-ADJ.NPT

SHD FILE.................................SHDFN................................
        LCL-SHD.NPT

BTH FILE.................................BTHFN................................
WB 1    LCL-BATH-2001-FINAL.NPT

MET FILE.................................METFN................................
WB 1    LCL-MET-2001.NPT

EXT FILE.................................EXTFN................................
WB 1    ext_wb1.npt

VPR FILE.................................VPRFN................................
WB 1    vpr_wb1.npt

LPR FILE.................................LPRFN................................
WB 1    lpr_wb1.npt

QIN FILE.................................QINFN................................
BR1     LCL-QIN-2001.NPT
BR2     LCL-BR2-QIN.NPT

TIN FILE.................................TINFN................................
BR1     LCL-TIN-2001.NPT
BR2     LCL-BR2-TIN.NPT

CIN FILE.................................CINFN................................
BR1     Cin br1.npt - not used
BR2     Cin_br2.npt - not used

QOT FILE.................................QOTFN................................
BR1     LCL-QOUT-2001-5STR-012214.NPT
BR2     qot_br2.npt - not used

QTR FILE.................................QTRFN................................
TR1     qtr_tr1.npt - not used

TTR FILE.................................TTRFN................................
TR1     ttr_tr1.npt - not used

CTR FILE.................................CTRFN................................
TR1     ctr_tr1.npt - not used

QDT FILE.................................QDTFN................................
BR1     LCL-QDT-2001.NPT
BR2     qdt_br2.npt - not used

TDT FILE.................................TDTFN................................
BR1     LCL-TDT-2001.NPT
BR2     tdt_br2.npt - not used

CDT FILE.................................CDTFN................................
BR1     cdt br1.npt - not used
BR2     cdt_br2.npt - not used

PRE FILE.................................PREFN................................
BR1     pre br1.npt - not used
BR2     pre_br2.npt - not used

TPR FILE.................................TPRFN................................
BR1     tpr br1.npt - not used
BR2     tpr_br2.npt - not used

CPR FILE.................................CPRFN................................
```

Figure B10. Page10 from CY01 w2_con.npt file.

```
BR1     cpr br1.npt - not used
BR2     cpr_br2.npt - not used

EUH FILE.................................EUHFN................................
BR1     euh br1.npt - not used
BR2     euh_br2.npt - not used

TUH FILE.................................TUHFN................................
BR1     tuh br1.npt - not used
BR2     tuh_br2.npt - not used

CUH FILE.................................CUHFN................................
BR1     cuh br1.npt - not used
BR2     cuh_br2.npt - not used

EDH FILE.................................EDHFN................................
BR1     edh br1.npt - not used
BR2     edh_br2.npt - not used

TDH FILE.................................TDHFN................................
BR1     tdh br1.npt - not used
BR2     tdh_br2.npt - not used

CDH FILE.................................CDHFN................................
BR1     cdh br1.npt - not used
BR2     cdh_br2.npt - not used

SNP FILE.................................SNPFN................................
WB 1    LCL-CY01-Run13-snp.opt

PRF FILE.................................PRFFN................................
WB 1    LCL-CY01-Run13-prf.opt

VPL FILE.................................VPLFN................................
WB 1    LCL-CY01-Run13-vpl.w2l

CPL FILE.................................CPLFN................................
WB 1    LCL-CY01-Run13-cpl.opt

SPR FILE.................................SPRFN................................
WB 1    LCL-CY01-Run13-spr.opt

FLX FILE.................................FLXFN................................
WB 1    LCL-CY01-Run13-kfl.opt

TSR FILE.................................TSRFN................................
        LCL-CY01-Run13-tsr.opt

WDO FILE.................................WDOFN................................
        LCL-CY01-Run13-wdo.opt
```

Table B1. Changes to calibration w2_con.npt file for other runs.

RUN	YEAR	TEMPI	TSED
Calibration-2001	2001	5.444	11.984
Verification-2003	2003	5.667	12.513
Verification-2010	2010	5.167	11.743

Table B2. Inventory of files needed to run the LCLM.

Run Name	CY01_Run13		CY03-Run03		CY10-Run02	
File Type	Calibration – 2001	Date Stamp	Verification – 2003	Date Stamp	Verification – 2010	Date Stamp
W2_CON.NPT	–	1/23/14 3:15 pm	–	2/11/14 11:35 am	–	2/11/14 11:35 am
WSC File	LCL-WSC-012314-ADJ.NPT	1/23/14 3:40 pm	LCL-WSC-012314-ADJ.NPT	1/23/14 3:40 pm	LCL-WSC-012314-ADJ.NPT	1/23/14 3:40 pm
SHD File	LCL-SHD.NPT	10/17/13 1:49 pm	LCL-SHD.NPT	10/17/13 1:49 pm	LCL-SHD.NPT	10/17/13 1:49 pm
BTH File	LCL-BATH-2001-FINAL.NPT	11/15/13 2:22 pm	LCL-BATH-2003-FINAL.NPT	11/15/13 2:24 pm	LCL-BATH-2010-FINAL.NPT	11/15/13 4:15 pm
MET File	LCL-MET-2001.NPT	1/27/14 10:54 am	LCL-MET-2003.NPT	1/27/14 10:56 am	LCL-MET-2010.NPT	1/27/14 10:48 am
QIN File	LCL-QIN-2001.NPT	1/22/13 10:52 am	LCL-QIN-2003.NPT	12/17/12 4:07 pm	LCL-QIN-2010.NPT	1/22/13 10:14 am
	LCL-BR2-QIN.NPT	12/17/12 4:18 pm	LCL-BR2-QIN.NPT	12/17/12 4:18 pm	LCL-BR2-QIN.NPT	12/17/12 4:18 pm
TIN File	LCL-TIN-2001.NPT	1/22/13 11:04 am	LCL-TIN-2003.NPT	12/17/12 4:23 pm	LCL-TIN-2010.NPT	1/22/13 11:03 am
	LCL-BR2-TIN.NPT	12/17/12 4:19 pm	LCL-BR2-TIN.NPT	12/17/12 4:19 pm	LCL-BR2-TIN.NPT	12/17/12 4:19 pm
QOT File	LCL-QOUT-2001-5STR-012214.NPT	1/22/14 1:03 pm	LCL-QOUT-2003-5STR.NPT	10/22/13 2:48 pm	LCL-QOUT-2010-5STR.NPT	1/7/14 2:59 pm
QDT File	LCL-QDT-2001.NPT	1/27/14 11:25 am	LCL-QDT-2003-2.NPT	2/11/14 12:21 pm	LCL-QDT-2010.NPT	2/11/14 12:23 pm
TDT File	LCL-TDT-2001.NPT	1/22/13 11:04 am	LCL-TDT-2003.NPT	1/22/13 11:04 am	LCL-TDT-2010.NPT	1/22/13 11:03 am

Table B3. Inventory of files needed to run the LCLPM (predictive model).

Run Name	CY01-USGS-PortRun13		CY03-USGS-PortRun01		CY10-USGS-PortRun01	
File Type	Calibration – 2001	Date Stamp	Verification – 2003	Date Stamp	Verification – 2010	Date Stamp
W2_CON.NPT	–	2/3/15 2:26 pm	–	2/4/15 8:36 am	–	2/4/2015 8:37 am
WSC File	LCL-WSC-012314-ADJ.NPT	1/23/14 3:40 pm	LCL-WSC-012314-ADJ.NPT	1/23/14 3:40 pm	LCL-WSC-012314-ADJ.NPT	1/23/14 3:40 pm
SHD File	LCL-SHD.NPT	10/17/13 1:49 pm	LCL-SHD.NPT	10/17/13 1:49 pm	LCL-SHD.NPT	10/17/13 1:49 pm
BTH File	LCL-BATH-2001-FINAL.NPT	11/15/13 2:22 pm	LCL-BATH-2003-FINAL.NPT	11/15/13 2:24 pm	LCL-BATH-2010-FINAL.NPT	11/15/13 4:15 pm
MET File	LCL-MET-2001.NPT	1/27/14 10:54 am	LCL-MET-2003.NPT	1/27/14 10:56 am	LCL-MET-2010.NPT	1/27/14 10:48 am
QIN File	LCL-QIN-2001.NPT	1/22/13 10:52 am	LCL-QIN-2003.NPT	12/17/12 4:07 pm	LCL-QIN-2010.NPT	1/22/13 10:14 am
	LCL-BR2-QIN.NPT	12/17/12 4:18 pm	LCL-BR2-QIN.NPT	12/17/12 4:18 pm	LCL-BR2-QIN.NPT	12/17/12 4:18 pm
TIN File	LCL-TIN-2001.NPT	1/22/13 11:04 am	LCL-TIN-2003.NPT	12/17/12 4:23 pm	LCL-TIN-2010.NPT	1/22/13 11:03 am
	LCL-BR2-TIN.NPT	12/17/12 4:19 pm	LCL-BR2-TIN.NPT	12/17/12 4:19 pm	LCL-BR2-TIN.NPT	12/17/12 4:19 pm
QOT File	LCL-QOUT-2001.NPT	5/23/14 9:10 am	LCL-QOUT-2003.NPT	10/27/14 3:14 pm	LCL-QOUT-2010.NPT	10/31/14 2:15 pm
QDT File	LCL-QDT-2001.NPT	1/27/14 11:25 am	LCL-QDT-2003-2.NPT	2/11/14 12:21 pm	LCL-QDT-2010.NPT	2/11/14 12:23 pm
TDT File	LCL-TDT-2001.NPT	1/22/13 11:04 am	LCL-TDT-2003.NPT	1/22/13 11:04 am	LCL-TDT-2010.NPT	1/22/13 11:03 am
W2_SELECTIVE.NPT	–	2/3/15 2:25 pm	–	2/3/15 2:25 pm	–	2/3/15 2:25 pm

**Note: The same w2_selective.npt file is used for all 3 cases!

Appendix C: LCLM and LCLPM Files

This appendix serves to provide a description of each file needed to run the model. The files are grouped by year. As an aside, ERDC typically has the following file organization system (see Table C1).

Table C1. Typical File Organization

CY01		Main folder for year identification for the particular model. Most models will be designed to run with multiple years.
	Results	Upon running the model, the results are moved out of the executables folder and into their own folder; typically, these folders are named something like CYXX_RunXX. NOTE: Always copy the control file (and any needed selective withdrawal files) used for the run into the results folder so that you can duplicate the run in the future if necessary.
	Executables	This is where all of the necessary files needed to run the model are located: W2 executables, Inflows, Outflows, Temperature/Concentration files, Met files, Bathymetry, etc.

Table C2. Files needed to run LCL model for each year.

File Description	CY01	CY03	CY10
Graph File	graph.npt	graph.npt	graph.npt
Control File	w2_con.npt	w2_con.npt	w2_con.npt
Bathymetry File	LCL-BATH-2001-FINAL.NPT	LCL-BATH-2003-FINAL.NPT	LCL-BATH-2010-FINAL.NPT
Meteorology File	LCL-MET-2001.NPT	LCL-MET-2003.NPT	LCL-MET-2010.NPT
Wind Sheltering Coefficient File	LCL-WSC-012314-ADJ.NPT	LCL-WSC-012314-ADJ.NPT	LCL-WSC-012314-ADJ.NPT
Shade File	LCL-SHD.NPT	LCL-SHD.NPT	LCL-SHD.NPT
Upstream Inflow File	LCL-QIN-2001.NPT	LCL-QIN-2003.NPT	LCL-QIN-2010.NPT
Upstream Temperature File	LCL-TIN-2001.NPT	LCL-TIN-2003.NPT	LCL-TIN-2010.NPT
Branch 2 Inflow File (zero)	LCL-BR2-QIN.NPT	LCL-BR2-QIN.NPT	LCL-BR2-QIN.NPT
Branch 2 Temperature File (placeholder)	LCL-BR2-TIN.NPT	LCL-BR2-TIN.NPT	LCL-BR2-TIN.NPT
Dam Outflow File	LCL-QOUT-2001-5STR.NPT	LCL-QOUT-2003-5STR.NPT	LCL-QOUT-2010-5STR.NPT
Distributed Tributary Inflow File	LCL-QDT-2001.NPT	LCL-QDT-2003-2.NPT	LCL-QDT-2010.NPT
Distributed Tributary Temperature File (duplicated upstream temps)	LCL-TDT-2001.NPT	LCL-TDT-2003.NPT	LCL-TDT-2010.NPT

Table C3. Files needed to run LCLPM model for each year.

File Description	CY01	CY03	CY10
Graph File	graph.npt	graph.npt	graph.npt
Control File	w2_con.npt	w2_con.npt	w2_con.npt
Selective Withdrawal Control File	w2_selective.npt	w2_selective.npt	w2_selective.npt
Target Temperature File	dynsplit_selectiveX.npt	dynsplit_selectiveX.npt	dynsplit_selectiveX.npt
Dam Outflow File	LCL-QOUT-2001.NPT	LCL-QOUT-2003.NPT	LCL-QOUT-2010.NPT
Distributed Tributary Inflow File	LCL-QDT-2001.NPT	LCL-QDT-2003-2.NPT	LCL-QDT-2010.NPT
Distributed Tributary Temperature File (duplicated upstream temps)	LCL-TDT-2001.NPT	LCL-TDT-2003.NPT	LCL-TDT-2010.NPT

**NOTE: All other files are the same as found in Table C2

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14. ABSTRACT

The U.S. Army Corps of Engineers Engineer Research and Development Center (USACE-ERDC) Environmental Lab (EL) assisted USACE, Portland District (CENWP) in updating a CE-QUAL-W2 (W2) model of Lost Creek Lake based on a previous version of W2. The model was calibrated using data from calendar year (CY) 2001 validated with data from calendar years 2003 and 2010. One set of W2 parameters were successfully applied to all calendar year types (2001 is a dry year; 2003 is a normal year; and 2010 is a wet year). This model and the corresponding results from the study provided CENWP with more refined estimates of water temperatures so that more defendable water temperature targets can be discussed with the state of Oregon. This is extremely important because the Rogue and Applegate temperature Total Maximum Daily Loads and Rogue Spring Chinook Conservation Plan require the Corps to review the Rogue Basin Project operations to determine whether improvements can be achieved to downstream temperature for the benefit of endangered fish. In addition to modeling the basic calibration for three years, a modified version of W2 was used to create a predictive model to determine the best blending of the intake ports to meet the temperature targets.

15. SUBJECT TERMS
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